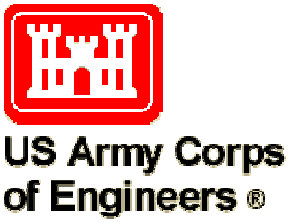
# N.C. Wetland Assessment Method (NC WAM)

## Draft User Manual


**Prepared by the N.C. Wetland Functional Assessment Team**






**Draft Version 5.0**
**May 15, 2007**

## EXECUTIVE SUMMARY

The North Carolina Wetland Assessment Method (NC WAM) is the culmination of a 3-year process begun in 2003 by an inter-agency team of federal and state agency staff – the N.C. Wetland Functional Assessment Team (WFAT). The goal of the WFAT was to develop an accurate, consistent, rapid, observational, and scientifically based field method to determine the level of function of a wetland relative to reference condition (where appropriate) for each of 16 North Carolina general wetland types. The WFAT defined "rapid" as taking no more than 15 additional minutes for a trained observer to evaluate a wetland within an assessment area.

The WFAT identified 16 general wetland types and cross-correlated them with the more precise N.C. Natural Heritage Program wetland types as well as other North Carolina wetland classifications. General wetland types are 1) Bottomland Hardwood Forest, 2) Riverine Swamp Forest, 3) Headwater Wetland, 4) Floodplain Pool, 5) Pocosin, 6) Hardwood Flat, 7) Pine Flat, 8) Pine Savanna, 9) Small-Basin Wetland, 10) Non-Riverine Swamp Forest, 11) Mountain Bog, 12) Seep, 13) Non-Tidal Freshwater Marsh, 14) Tidal Freshwater Marsh, 15) Salt/Brackish Marsh, and 16) Estuarine Woody Wetland. A dichotomous key is used for wetland type identification.

Functional ratings are developed for each assessment area wetland type in comparison to a reference wetland. Since some of the 16 general wetland types comprise several distinctive types of wetlands, NC WAM users must be careful to make an appropriate comparison to wetland type reference condition. Three major functions are recognized with 11 sub-functions as follows – hydrology (surface storage and retention and sub-surface storage and retention), water quality (pathogen change, particulate change, soluble change, physical change, and pollution change), and habitat (habitat physical structure, landscape patch structure, vegetative composition, and habitat uniqueness). Sub-functions and functions are evaluated using 22 field metrics listed on a field assessment form. These metrics have been designed and tested to be appropriate to North Carolina wetland types. Stressors are identified which can lower the level of wetland function. Completed field assessment form data are entered into a computer program to generate High, Medium, and Low ratings for each sub-function, function, and the assessment area. The sub-function ratings are reported both with and without consideration of the opportunity that the wetland has to perform specific functions. The computer program was developed based on an iterative Boolean logic process and then field tested across the state at various sites. A GIS-based "Tool Box" of previously evaluated reference and non-reference sites is available to help calibrate the evaluator for nearby sites via an internet website.

This User Manual describes each of the 22 metrics with examples to calibrate the user. The WFAT expects that a multi-day training class, coupled with subsequent field experience with the methodology, will be needed to use NC WAM properly, and WFAT members are working to develop a class for public agency staff as well as the public. The User Manual also contains a comprehensive Glossary of Terms used by NC WAM as well as other detailed appendices. NC WAM may be used for project planning, alternatives analysis, compliance/enforcement, mitigation planning, and tracking functional replacement. The details of how NC WAM will be used will be developed by the regulatory agencies after appropriate public notice and comment.

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## Dichotomous Key to General North Carolina Wetland Types, v5.14, 3/16/07

Before using this key, the assessor should have read and become familiar with the descriptions of the general wetland types. The assessor should use best professional judgment to verify that the wetland type determined with the use of this key matches the written description.

The following rules should be used to assist the assessor in the selection of the most appropriate general wetland type. Narrative descriptions are also available to assist in this choice (see User Manual Section 3.1).

> Wetlands with modifications (man-made or natural) should generally be classified as the original, naturally occurring type if this determination can be made. However, if the full range of stable, existing wetland characteristics (vegetation, hydrology, and soils) better resemble another wetland type because of long-established, permanent alterations, the wetland should be classified as this current, more appropriate type.

If there is evidence suggesting the wetland is a type other than the keyed type, the wetland may be classified as the evidenced type. Also, if the wetland does not appear to conform to any of the following general types, the site should be evaluated based on what the assessor believes is the closest wetland type. If the wetland is "intensively managed" or "intensively disturbed," the assessor should note this fact on the field assessment form and then select the most appropriate general wetland type based on the guidance provided above.

I. Wetland affected by lunar or wind tide, may include woody areas adjacent to tidal marsh
   A. Wetland affected, at least occasionally, by brackish or salt water
      i. Dominated by herbaceous vegetation – **Salt/Brackish Marsh**
      ii. Dominated by woody vegetation – **Estuarine Woody Wetland**
   B. Wetland primarily affected by freshwater
      i. Dominated by herbaceous vegetation – **Tidal Freshwater Marsh**
      ii. Dominated by woody vegetation – **Riverine Swamp Forest**

II. Wetland not affected by tides
   A. Not in a geomorphic floodplain and not associated with a natural linear conveyance (such as a topographic crenulation), nor associated with a natural lake greater than or equal to 20 acres in size
      i. On a side slope – **Seep**
      ii. On interstream divides or on a coastal island
         1. Flats or interstream divides in Coastal Plain ecoregions
            a. Dominated by deciduous trees
               i. Intermittently to seasonally inundated (typically dominated by sweetgum and oaks) – **Hardwood Flat**
               ii. Seasonally to semi-permanently inundated (typically dominated by cypress and blackgum) – **Non-Riverine Swamp Forest**
            b. Dominated by evergreens
               i. Dominated by dense, waxy shrub species (typically include gallberries, fetterbushes, honeycup, greenbriar); canopy may include pond pine, Atlantic white cedar, and bays – **Pocosin**
               ii. Not dominated by dense, waxy shrub species
                  1. Dominated by long-leaf or pond pine and wire grass – **Pine Savanna**
                  2. Dominated by loblolly or slash pines – **Pine Flat**
         2. In depressions surrounded by uplands anywhere in the state (mafic depressions, lime sinks, Carolina bays) or on shorelines of lakes/pond

## DICHOTOMOUS KEY TO GENERAL NC WETLAND TYPES, CONTINUED

2. In depressions surrounded by uplands anywhere in the state (mafic depressions, lime sinks, Carolina bays) or on shorelines of lakes/ponds (repeated from the previous page)
    a. Dominated by dense, waxy shrub species (typically include gallberries, fetterbushes, honeycup, greenbriar; canopy may include pond pine, Atlantic white cedar, and bays) and not characterized by clay-based soils– **Pocosin**
    b. Not dominated by dense, waxy shrub species and not characterized by a peat-filled bay – **Small-Basin Wetland**

B. In a geomorphic floodplain or associated with a natural linear conveyance (such as a topographic crenulation) or along shorelines of natural water bodies greater than 20 acres or artificial impoundments
    i. Northern Inner Piedmont or Blue Ridge Mountains ecoregions and dense herbaceous or mixed shrub/herbaceous vegetation with characteristic bog species (see wetland type description), with or without tree canopy; typically long-duration saturation; sphagnum moss commonly present – **Mountain Bog**
    ii. Anywhere in the state and not Mountain Bog
        1. Dominated by herbaceous vegetation. At least semi-permanently inundated or saturated. Includes lacustrine and riverine fringe, and beaver ponds with dense herbaceous vegetation of large, grass-like plants and forbs, sphagnum moss scarce or absent – **Non-tidal Freshwater Marsh**
        2. Dominated by woody vegetation. Trees may be present on edges or hummocks.
            a. Localized depression; semi-permanently inundated – **Floodplain Pool**
            b. Not a localized depression
                i. Zero- to 1st-order stream[1]. May be 2nd- or 3rd-order stream in Sandhills level IV ecoregion. Diffuse surface flow and groundwater more important than overbank flooding.
                    1. Intermittently inundated to seasonally saturated – **Headwater Wetland**
                    2. Seasonally to semi-permanently inundated – **Riverine Swamp Forest**
                ii. Second-order or greater stream or associated with the shoreline of waterbodies 20 acres or greater
                    1. Intermittently to seasonally inundated for long duration (may be dominated by sweetgum, ash, sycamore, and oaks) – **Bottomland Hardwood Forest**
                    2. Seasonally to semi-permanently inundated for very long duration (may be dominated by cypress and blackgums in Coastal Plain and ash, overcup oak, and elms in Piedmont and Mountains) – **Riverine Swamp Forest**

[1]See stream order schematic diagram in User Manual Appendix C.

**NC WAM FIELD ASSESSMENT FORM**
**VERSION 3.13 (January 12, 2007)**

| | | | |
|---|---|---|---|
| **Wetland Site Name** | | **Date** | |
| **Wetland Type** | | **Assessor Name/Organization** | |
| **Level III Ecoregion** | | **Nearest Named Water Body** | |
| **River Basin** | | **USGS 8-Digit Catalogue Unit** | |
| ☐ **Yes** ☐ **No** | **Precipitation within 48 hrs?** | **Latitude/Longitude (deci-degrees)** | |

**Evidence of stressors affecting the assessment area (may not be within the assessment area)**
Please circle and/or make note below if evidence of stressors is apparent. Consider departure from reference, if appropriate, in recent past (for instance, within 10 years). Noteworthy stressors include, but are not limited to the following.

- Hydrological modifications (examples: ditches, dams, beaver dams, dikes, berms, ponds, etc.)
- Surface and sub-surface discharges into the wetland (examples: discharges containing obvious pollutants, presence of nearby septic tanks, underground storage tanks (USTs), hog lagoons, etc.)
- Signs of vegetation stress (examples: vegetation mortality, insect damage, disease, storm damage, salt intrusion, etc.)
- Habitat/plant community alteration (examples: mowing, clear-cutting, exotics, etc.)

**Is the assessment area intensively managed?** ☐ Yes ☐ No

**Describe effects of stressors that are present**.

**Regulatory Considerations**
Select all that apply to the assessment area.

☐ Anadromous fish
☐ Federally protected species or State endangered or threatened species
☐ NCDWQ riparian buffer rule in effect
☐ Wetland adjacent to or associated stream drains to a Primary Nursery Area
☐ Publicly owned property
☐ N.C. Division of Coastal Management Area of Environmental Concern (AEC) (including buffer)
☐ N.C. Division of Water Quality best usage classification of SA or supplemental classifications of HQW, ORW, or Trout
☐ Designated NCNHP reference community

**What type of natural stream is associated with the wetland, if any? (Check all that apply)**

☐ Blackwater
☐ Brownwater
☐ Tidal (if tidal, check one of the following boxes) ☐ Lunar ☐ Wind ☐ Both

**Is the assessment area on a coastal island?** ☐ Yes ☐ No

**Is the assessment area's surface water storage capacity or duration substantially altered by beaver?** ☐ Yes ☐ No

**1. Ground Surface Condition/Vegetation Condition – assessment area condition metric**

**Check a box in each column.** Consider alteration to the ground surface (GS) in the assessment area and vegetation structure (VS) in the assessment area. Compare to reference wetland if applicable (see User Manual v1.0). If a reference is not applicable, then rate the assessment area based on evidence of alteration.

| GS | VS | |
|---|---|---|
| ☐A | ☐A | Not severely altered |
| ☐B | ☐B | Severely altered over most of the assessment area (ground surface alteration examples: vehicle tracks, excessive sedimentation, fire-plow lanes, skidder tracks, bedding, fill, soil compaction, obvious pollutants) (vegetation structure alteration examples: mechanical disturbance, herbicides, salt intrusion [where appropriate], exotic species, grazing, less diversity [if appropriate], artificial hydrologic alteration) |

**2. Surface and Sub-Surface Storage Capacity and Duration – assessment area condition metric**

**Check a box in each column.** Consider surface storage capacity and duration (Surf) and sub-surface storage capacity and duration (Sub). Consider both increase and decrease in hydrology. Refer to the NRCS Scope and Effect Guide (see User Manual v1.0 Appendix G) for North Carolina hydric soils for the zone of influence of ditches in hydric soils. A ditch ≤ 1 foot deep is considered to affect surface water only, while a ditch > 1 foot deep is expected to affect both surface and sub-surface water. Consider tidal flooding regime, if applicable.

| Surf | Sub | |
|---|---|---|
| ☐A | ☐A | Water storage capacity and duration are not altered. |
| ☐B | ☐B | Water storage capacity or duration are altered, but not substantially (typically, not sufficient to change vegetation). |
| ☐C | ☐C | Water storage capacity or duration are substantially altered (typically, alteration sufficient to result in vegetation change) (examples: intensive ditching, fill, sedimentation, channelization, diversion, man-made berms, beaver dams, stream incision, sewer lines, soil compaction). |

**3. Water Storage/Surface Relief – assessment area/wetland type condition metric**

**Check a box in each column**. Select the appropriate storage for the assessment area (AA) and the wetland type (WT).

| AA | WT | |
|---|---|---|
| ☐A | ☐A | > 50% of the wetland type with depressions able to pond water > 2 feet |
| ☐B | ☐B | > 50% of the wetland type with depressions able to pond water 1 to 2 feet |
| ☐C | ☐C | > 50% of wetland type with depressions able to pond water 6 inches to 1 foot |
| ☐D | ☐D | > 50% of wetland type with depressions able to pond water 3- to 6-inches deep |
| ☐E | ☐E | Depressions able to pond water < 3-inches deep |

**4. Soil Texture/Structure – assessment area condition metric**

**Select all that apply.** Dig soil profile in the dominant assessment area landscape feature. Make soil observations within the top foot. National Technical Committee for Hydric Soils regional indicators are noted (use most recent guidance).

☐A Sandy soil
☐B Predominantly characterized by mottled (redoxymorphic features), mineral soil (F6, F8, F12, TF10, S5, S6)
☐C Predominantly characterized by other, mineral soil (no mottling)
☐D Gleyed mineral soil (F2, S4)
☐E Soil ribbon < 1 inch
☐F Soil ribbon ≥ 1 inch
☐G No peat or muck presence
☐H A peat or muck presence (A6, A7, A8, A9, A10, F1, S1)
☐I Peat or muck soil (histosol or histic epipedon) (A1, A2, A3)

**5. Discharge into Wetland – opportunity metric**

**Check a box in each column.** Consider surface pollutants or discharges (Surf) and sub-surface pollutants or discharges (Sub). Examples of sub-surface discharges include presence of nearby septic tank, underground storage tank (UST), etc.

| Surf | Sub | |
|---|---|---|
| ☐A | ☐A | Little or no evidence of pollutants or discharges entering the assessment area |
| ☐B | ☐B | Noticeable evidence of pollutants or discharges entering the wetland and stressing, but not overwhelming the treatment capacity of the assessment area |
| ☐C | ☐C | Noticeable evidence of pollutants or discharges (pathogen, particulate, or soluble) entering the assessment area and potentially overwhelming the treatment capacity of the wetland (water discoloration, dead vegetation, excessive sedimentation) |

**6. Land Use – opportunity metric**

**Check all that apply.** Evaluation of this metric involves a GIS effort with field adjustment. Consider sources draining to assessment area within entire upstream watershed (WS), within 5 miles and within the watershed draining to the assessment area (5M), and within 2 miles and within the watershed draining to the assessment area (2M). Effective riparian buffers are considered to be 50 feet wide in the Coastal Plain and Piedmont and 30 feet wide in the Mountains.

| WS | 5M | 2M | |
|---|---|---|---|
| ☐A | ☐A | ☐A | > 30% impervious surfaces with stormwater Best Management Practices (BMPs) (land use examples: industrial, commercial, and high-density residential) |
| ☐B | ☐B | ☐B | > 30% impervious surfaces without stormwater BMPs |
| ☐C | ☐C | ☐C | 10 to 30% impervious surfaces |
| ☐D | ☐D | ☐D | < 10% impervious surfaces |
| ☐E | ☐E | ☐E | Old urban development (pink areas on USGS 7.5-minute quadrangles) |
| ☐F | ☐F | ☐F | New adjacent development |
| ☐G | ☐G | ☐G | Confined animal operations (or other local, concentrated source of pollutants) |
| ☐H | ☐H | ☐H | ≥ 20% coverage of pasture without riparian buffer |
| ☐I | ☐I | ☐I | ≥ 20% coverage of pasture with effective riparian buffer |
| ☐J | ☐J | ☐J | ≥ 20% coverage of agricultural land (regularly plowed land) without riparian buffer |
| ☐K | ☐K | ☐K | ≥ 20% coverage of agricultural land (regularly plowed land) with effective riparian buffer |
| ☐L | ☐L | ☐L | ≥ 20% coverage of maintained grass/herb |
| ☐M | ☐M | ☐M | Silvicultural land with disturbance < 5 years old |
| ☐N | ☐N | ☐N | Little or no opportunity. Lack of opportunity may result from hydrologic modifications that prevent drainage or overbank flow from affecting the assessment area. |

**7. Wetland Acting as Vegetated Buffer – assessment area condition metric**

Is the assessment area within 50 feet of a stream or other open water? ("open water" does not include man-made ditches or canals)
☐Yes ☐No If No, skip to next metric.

Stream width (Stream width is normal flow width [ordinary high water to ordinary high water]). If the stream is anastomosed, combine widths of channels/braids for a total stream width.
☐≤ 15-feet wide ☐> 15-feet wide ☐Not Applicable

Do roots of assessment area vegetation extend into the bank of the adjacent stream/open water?
☐Yes ☐No

Is stream or other open water sheltered or exposed?
☐Sheltered – adjacent open water with width < 2500 feet and no regular boat traffic.
☐Exposed – adjacent open water with width ≥ 2500 feet or regular boat traffic.

**8. Wetland/Riparian Buffer Width – assessment area/wetland type/wetland complex metric**

**Check a box in each column.** Select the appropriate width for the wetland type at the assessment area (WT), the wetland complex (WC), and the riparian buffer at the assessment area (RB) (if applicable). Riparian buffer width is measured from top of bank and need only be present on one side of the water body. The riparian buffer is measured from the outside banks of the outer channels of an anastomosed system. Make buffer judgment based on dominant landscape feature. Record a note if a portion of the buffer has been removed or disturbed.

| WT | WC | RB (if applicable) | |
|---|---|---|---|
| ☐A | ☐A | ☐A | ≥ 100 feet |
| ☐B | ☐B | ☐B | From 80 to < 100 feet |
| ☐C | ☐C | ☐C | From 50 to < 80 feet |
| ☐D | ☐D | ☐D | From 40 to < 50 feet |
| ☐E | ☐E | ☐E | From 30 to < 40 feet |
| ☐F | ☐F | ☐F | From 15 to < 30 feet |
| ☐G | ☐G | ☐G | From 5 to < 15 feet |
| ☐H | ☐H | ☐H | < 5 feet |

**9. Inundation Duration – assessment area condition metric**

Answer for assessment area dominant landform.

☐A Evidence of short-duration inundation (< 7 consecutive days)
☐B Evidence of saturation, without evidence of inundation
☐C Evidence of long-duration inundation (7 to 30 consecutive days or more)

**10. Indicators of Deposition – assessment area condition metric**

Consider recent deposition only (no plant growth since deposition).

☐A Sediment deposition is not excessive, but at approximately natural levels.
☐B Sediment deposition is excessive, but not overwhelming the wetland.
☐C Sediment deposition is excessive and is overwhelming the wetland.

**11. Wetland Size – wetland type/wetland complex condition metric**

**Check a box in each column.** Involves a GIS effort with field adjustment. This metric evaluates three aspects of the wetland area: the size of the wetland type (WT), the size of the contiguous wetland complex (WC), and the size of the contiguous, forested wetland (FW) (if applicable, see User Manual). Boundaries are formed by uplands, four-lane roads, or urban landscapes. An observed beaver pond forms a boundary if it extends across the entire width of the floodplain. Additionally, other wetland types are considered boundaries for column WT. If assessment area is clear-cut, select "K" for FW column.

| WT | WC | FW (if applicable) | |
|---|---|---|---|
| ☐A | ☐A | ☐A | ≥ 500 acres |
| ☐B | ☐B | ☐B | From 100 to < 500 acres |
| ☐C | ☐C | ☐C | From 50 to < 100 acres |
| ☐D | ☐D | ☐D | From 25 to < 50 acres |
| ☐E | ☐E | ☐E | From 10 to < 25 acres |
| ☐F | ☐F | ☐F | From 5 to < 10 acres |
| ☐G | ☐G | ☐G | From 1 to < 5 acres |
| ☐H | ☐H | ☐H | From 0.5 to < 1 acre |
| ☐I | ☐I | ☐I | From 0.1 to < 0.5 acre |
| ☐J | ☐J | ☐J | From 0.01 to < 0.1 acre |
| ☐K | ☐K | ☐K | < 0.01 acre |

**12. Wetland Intactness – wetland type condition metric (evaluate for Pocosins only)**

☐A Wetland type is the full extent (≥ 90%) of its natural landscape size.
☐B Wetland type is < 90% of the full extent of its natural landscape size.

**13. Connectivity to Other Natural Areas – landscape condition metric**

**Check appropriate box(es).** This metric refers to the landscape patch, the contiguous naturally vegetated area and open water (if appropriate) that includes the wetland type. Boundaries are formed by four-lane roads, urban landscapes, maintained fields (pasture and agriculture), or open water > 300 feet wide. Consider if the wetland type is well-connected (WC) or loosely-connected (LC) to the landscape patch.

| WC | LC | |
|---|---|---|
| ☐A | ☐A | ≥ 500 acres |
| ☐B | ☐B | From 100 to < 500 acres |
| ☐C | ☐C | From 50 to < 100 acres |
| ☐D | ☐D | From 10 to < 50 acres |
| ☐E | ☐E | < 10 acres |
| ☐F | ☐F | Wetland type has a poor or no connection to other natural habitats |

**Check Yes or No.**

☐Yes ☐No Does wetland type have a surface hydrology connection to open waters or tidal wetlands? (evaluate for marshes only)
☐Yes ☐No Is the assessment area subject to overbank flooding during normal conditions?

**14. Edge Effect – wetland type condition metric**

Estimate distance from wetland type boundary to artificial edges. Artificial edges include permanent features such as fields, development, two-lane or larger roads (≥ 40-feet wide), utility line corridors wider than a two-lane road, and clear-cuts < 10 years old. Consider the eight main points of the compass.

☐A No artificial edge within 150 feet in all directions
☐B No artificial edge within 150 feet in four to seven directions
☐C An artificial edge occurs within 150 feet in more than four directions or assessment area is clear-cut

**15. Vegetative Composition – assessment area condition metric (skip for marshes and Pine Flat)**

☐A Vegetation is close to reference condition in species present and their proportions. Lower strata composed of appropriate species, with exotic plants absent or sparse within the assessment area.
☐B Vegetation is different from reference condition in species diversity or proportions, but still largely composed of native species characteristic of the wetland type. This may include communities of weedy native species that develop after clearcutting or clearing. It also includes communities with exotics present, but not dominant, over a large portion of the expected strata.
☐C Vegetation severely altered from reference in composition. Expected strata are unnaturally absent or dominated by exotic species or composed of planted stands of non-characteristic species or inappropriately composed of a single species.

**16. Vegetative Diversity – assessment area condition metric (evaluate for Non-tidal Freshwater Marsh only)**

☐A Vegetation diversity is high and is composed primarily of native species.
☐B Vegetation diversity is low or has > 10% cover of exotics.
☐C Vegetation is dominated by exotic species.

**17. Vegetative Structure – assessment area/wetland type condition metric**

☐ **Vegetation present**

**Evaluate percent coverage of vegetation for marshes only**

☐A ≥ 25% coverage of vegetation
☐B < 25% coverage of vegetation

**Check a box in each column for each stratum. Evaluate this portion of the metric for non-marsh wetlands. Consider structure in airspace above the assessment area (AA) and the wetland type (WT) separately.**

| AA | WT | |
|---|---|---|
| ☐A | ☐A | Canopy closed, or nearly closed, with natural gaps associated with natural processes |
| ☐B | ☐B | Canopy present, but opened more than natural gaps |
| ☐C | ☐C | Canopy sparse or absent |
| ☐A | ☐A | Dense mid-story/sapling layer |
| ☐B | ☐B | Moderate density mid-story/sapling layer |
| ☐C | ☐C | Mid-story/sapling layer sparse or absent |
| ☐A | ☐A | Dense shrub layer |
| ☐B | ☐B | Moderate density shrub layer |
| ☐C | ☐C | Shrub layer sparse or absent |
| ☐A | ☐A | Dense herb layer |
| ☐B | ☐B | Moderate density herb layer |
| ☐C | ☐C | Herb layer sparse or absent |

☐ **Vegetation absent**

**18. Snags – wetland type condition metric**

☐A Large snags (more than one) are present (> 12-inches DBH, or large relative to species present and landscape stability).
☐B Not A

**19. Diameter Class Distribution – wetland type condition metric**

☐A Most canopy trees have stems > 6-inches in diameter at breast height (DBH); many large trees (> 12-inches DBH) are present.
☐B Most canopy trees have stems between 6- and 12-inches DBH, few are > 12-inch DBH.
☐C Most canopy trees are < 6-inches DBH or no trees.

**20. Large Woody Debris – wetland type condition metric**

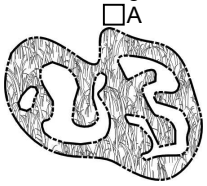
Include both man-made and natural debris piles.

☐A Large logs (more than one) are present (> 12-inches in diameter, or large relative to species present and landscape stability).
☐B Not A

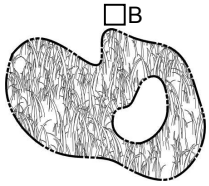
**21. Vegetation/Open Water Dispersion – wetland type/open water condition metric (evaluate for Non-Tidal Freshwater Marsh only)**

Select the figure that best describes the amount of interspersion between vegetation and open water in the growing season. Patterned areas indicate vegetated areas, while solid white areas indicate open water.

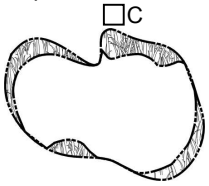
☐A



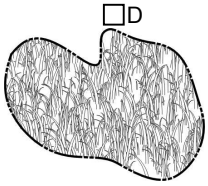
☐B



☐C



☐D



**22. Habitat Uniqueness – wetland type condition metric**

☐Yes ☐No Has the N.C. Environmental Management Commission classified the assessment area as “Unique Wetlands” (UWL)?

Notes

# NC WAM Wetland Rating Sheet

Wetland Site Name _____ Date of Assessment _____

Wetland Type _____ Assessor Name/Organization _____

Presence of stressor affecting assessment area (Y/N) _____

Notes on Field Assessment Form (Y/N) _____

Presence of regulatory considerations (Y/N) _____

Wetland is intensively managed (Y/N) _____

Wetland may be a high-quality riverine wetland (Y/N) _____

**Sub-function Rating Summary**

| Function | Sub-function | Metrics | Rating |
|---|---|---|---|
| Hydrology | Surface Storage and Retention | Condition | |
| | Sub-surface Storage and Retention | Condition | |
| Water Quality | Pathogen Change | Condition | |
| | | Condition/Opportunity | |
| | | Opportunity Presence (Y/N) | |
| | Particulate Change | Condition | |
| | | Condition/Opportunity | |
| | | Opportunity Presence (Y/N) | |
| | Soluble Change | Condition | |
| | | Condition/Opportunity | |
| | | Opportunity Presence (Y/N) | |
| | Physical Change | Condition | |
| | | Condition/Opportunity | |
| | | Opportunity Presence (Y/N) | |
| | Pollution Change | Condition | |
| | | Condition/Opportunity | |
| | | Opportunity Presence (Y/N) | |
| Habitat | Physical Structure | Condition | |
| | Landscape Patch Structure | Condition | |
| | Vegetation Composition | Condition | |
| | Uniqueness | Condition | |

**Function Rating Summary**

| Function | Metrics | Rating |
|---|---|---|
| Hydrology | Condition | |
| Water Quality | Condition | |
| | Condition/Opportunity | |
| | Opportunity Presence (Y/N) | |
| Habitat | Condition | |

## Overall Wetland Rating _____

# NORTH CAROLINA WETLAND ASSESSMENT METHOD (NC WAM)

# USER MANUAL

## 1.0 INTRODUCTION

### 1.1 Background

This manual provides guidance for the use of the field-based, rapid wetland assessment method, the N.C. Wetland Assessment Method (NC WAM). Companion documents to this manual are an initial position paper (white paper – entitled "Status Report: North Carolina Wetland Functional Assessment," dated January 13, 2004), which describes the purpose, reasoning, and process behind the development of this method; an intermediate development position paper (gray paper – entitled "Report of the North Carolina Wetland Functional Assessment Team GIS- and Field-Based Methods [Final, but Not Complete]," dated October 15, 2004), which describes the decision-making process during development of this method; and a technical document (entitled "N.C. Wetland Assessment Method [NC WAM] Technical Document," expected completion early 2007), which describes technical issues associated with various components of NC WAM. NC WAM was developed as part of a collaborative effort by representatives of the U.S. Army Corps of Engineers (USACE), U.S. Department of Transportation Federal Highway Administration (FHWA), U.S. Environmental Protection Agency (USEPA), U.S. Fish and Wildlife Service (USFWS), N.C. Division of Coastal Management (NCDCM), N.C. Department of Transportation (NCDOT), N.C. Division of Water Quality (NCDWQ), N.C. Wildlife Resources Commission (NCWRC), and N.C. Natural Heritage Program (NCNHP).

In May 2003, the USACE, NCDWQ, and NCDOT, with the active participation of several other state and federal agencies, established the N.C. Wetland Functional Assessment Team (WFAT) to address and develop an accurate, consistent, rapid, observational, and scientifically based field method for wetland functional assessment. The WFAT had its last meeting in June 2005. WFAT members were as follows.

N.C. Division of Water Quality – John Dorney (Co-Chair)
N.C. Department of Transportation – LeiLani Paugh (Co-Chair)
U.S. Army Corps of Engineers – Dave Lekson and Amanda Jones
U.S. Fish and Wildlife Service – Gary Jordan (replaced by Howard Hall)
N.C. Division of Coastal Management – Kelly Williams (replaced by Melissa Carle)
U.S. Environmental Protection Agency – Kathy Matthews and Becky Fox
N.C. Wildlife Resources Commission – David Cox
Ecosystem Enhancement Program – Jim Stanfill
N.C. Natural Heritage Program – Mike Schafale
Federal Highway Administration – Clarence Coleman and Donnie Brew
U.S. Army Corps of Engineers (Coordination Group representative) – Scott McLendon

In addition, the team was ably assisted by staff of EcoScience Corporation (Sandy Smith, Matt Cusack, and Brad Allen) in development and testing of this method.

WFAT met from May 2003 to June 2005. During the development and testing of NC WAM, the WFAT visited 74 wetland sites across the state and spent over 130 person-days in the field.

## 1.2 Purpose and Overview of NC WAM

The purpose of NC WAM is to provide the public and private sectors with an accurate, consistent, rapid, observational, and scientifically-based field method to determine the level of function of wetlands relative to reference condition (when appropriate) for each general wetland type identified within North Carolina. For this method, the term "rapid" is defined as taking no more than 15 minutes for a trained individual (assessor) to evaluate a defined wetland within an "assessment area" after a jurisdictional delineation has been completed. This method will not replace more comprehensive wetland evaluation methods that may be more appropriate for other purposes. However, NC WAM is expected to replace other rapid assessment methods in North Carolina (such as the NCDWQ Guidance for Rating the Values of Wetlands in North Carolina [NCDEM 1995]).

NC WAM defines 16 general wetland types in North Carolina, described in Section 3.1. NC WAM generates an overall functional rating relative to reference for each wetland type. Functional ratings depend on indicators of function rather than actual measurements of function. Functional ratings are generated based on an assessor's evaluation of 22 questions (metrics) concerning wetland field indicators. The 22 metrics are presented on the NC WAM Field Assessment Form. The Field Assessment Form is included with NC WAM forms at the beginning of the User Manual. A discussion of individual metrics and guidance for use of metrics are provided in Section 4.3.2. To complete the Field Assessment Form, the assessor selects the appropriate answer(s), or descriptor(s), for each metric. The selected descriptors are then converted by a computer program (the NC WAM rating calculator) into a functional rating for each metric. Ratings are coarse and are provided as "High," "Medium," or "Low" relative only to other wetlands of the same type. Metric ratings are combined to generate sub-function ratings using a weighting strategy that reflects the relative importance of the metric to the wetland sub-functions. Likewise, sub-function ratings are combined to generate function ratings (Hydrology, Water Quality, and Habitat; see Section 5.4.1), and wetland function ratings are combined to yield an overall wetland rating. Ratings are provided on a Wetland Rating Sheet. The Wetland Rating Sheet is included with NC WAM forms at the beginning of the User Manual.

General wetland types have been defined with wetland function in mind. Functions are considered to vary among these wetland types, but are relatively consistent within each wetland type (when wetlands of a particular type are located in the same ecoregion). NC WAM generates functional ratings for each assessed wetland through comparison with reference examples of the same wetland type only (in-kind functional assessment). This approach allows each wetland to be located on a conceptual functional continuum, ranging in extreme from

relatively undisturbed, reference examples of the specific wetland type (functional rating of "High") to heavily disturbed examples of the same wetland type (functional rating of "Low"). The developers of NC WAM have reasoned that the generation of an in-kind functional assessment rating for each wetland will give a true indication of the function or importance of that wetland based on its landscape position and level of disturbance. The functional rating produced by NC WAM will thereby provide regulators, planners, and the general public with better information than previously available for use in the consideration of wetland function when evaluating potential wetland impacts and mitigation activities.

Unique to the Water Quality functions, NC WAM generates two wetland functional ratings: the first is a reflection of wetland condition (the same for all functions) as represented by on-site indicators of function, and the second is wetland condition as modified by wetland opportunity. Wetland opportunity is determined by the state of the watershed draining to a specific wetland (see Section 2.2). The distinction acknowledges that in some cases (specifically for Water Quality), the state (degree of disturbance) of the immediate watershed may increase the wetland's opportunity to provide function. The proximity of wetlands to disturbance within a watershed may only increase the functional rating. Both wetland functional ratings are provided on the Wetland Rating Sheet. The Wetland Rating Sheet is included with NC WAM forms at the beginning of the User Manual.

Results of NC WAM are in no way designed or expected to dictate decisions by regulatory agencies (the term "regulatory agencies" includes permitting agencies). NC WAM has been designed by an interagency team to provide project reviewers with a consistent tool to aid in consideration of design and a base of information concerning assessed wetland characteristics and functions that may be used at the discretion of the regulatory community. Experience has shown that regulatory concerns will change over time, but this assessment method is intended to provide a consistent source of functional assessment information to support the regulatory review process. It is fully expected by the developers of NC WAM that the current method may be modified for more specific applications concerning project planning, alternatives analysis, compliance/enforcement, mitigation planning, and mitigation success monitoring, as well as updates as more scientific information becomes available.

### 1.3 Organization of the User Manual

The main body of the User Manual provides an introduction to NC WAM, a conceptual discussion of the NC WAM approach to wetland functions and sub-functions, a general discussion of the wetland classification system (including detailed descriptions of the general wetland types utilized by NC WAM, a discussion of the concept of reference wetlands, and guidance for use of the key to general wetland types), a discussion of functional assessment metrics including guidance for evaluating metrics in the field, and guidance for implementation of NC WAM. To promote ease of reference, additional information necessary for the implementation of NC WAM has been organized into the attached appendices. The Table of Contents contains a complete list of information provided in the appendices. Many terms used

in the manual and appendices are defined in the NC WAM glossary of terms (Appendix K). Abbreviations used in NC WAM are defined in Appendix A.

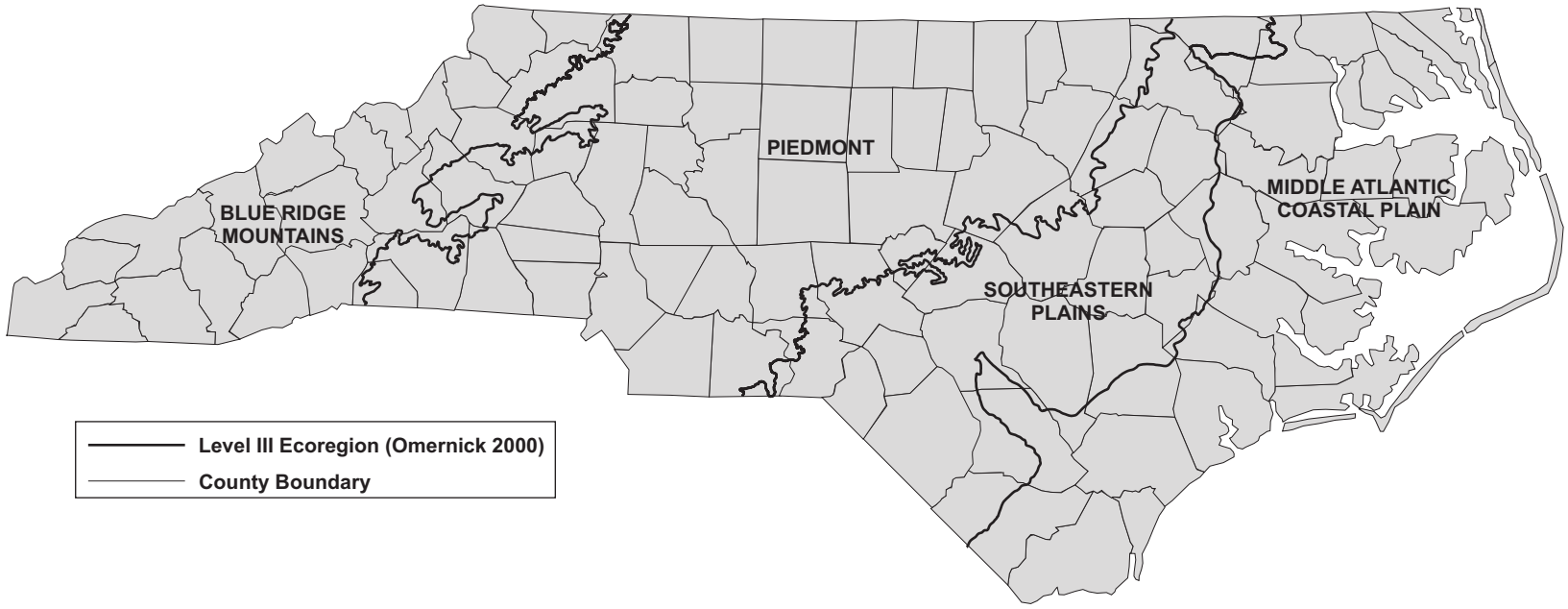
Throughout the User Manual, NC WAM general wetland types are discussed in terms of occurrence within the four level III ecoregions of North Carolina (Griffith et al. 2002). The level III ecoregions of North Carolina, from east to west, include 1) Middle Atlantic Coastal Plain, 2) Southeastern Plains, 3) Piedmont, and 4) Blue Ridge Mountains (Figure 1 and Appendix F). For the sake of simplicity, the Middle Atlantic Coastal Plain (commonly known as the Inner Coastal Plain) and Southeastern Plains (commonly known as the Outer Coastal Plain) are collectively referred to as the Coastal Plains ecoregions. In some cases, wetlands are further differentiated based on occurrence in the Sandhills level IV ecoregion (a subset of the Southeastern Plains level III ecoregion). More detailed descriptions of the ecoregions, including correlations between North Carolina physiographic provinces, are provided in the NC WAM glossary (Appendix K).

## 2.0 GENERAL APPROACH TO WETLAND FUNCTIONS AND SUB-FUNCTIONS

### 2.1 Wetland Functions and Sub-functions

NC WAM considers chemical, physical, and biological functions for each general wetland type, and assesses the general performance of each specific function relative to that wetland type. Scientific literature, existing wetland functional assessment methods, and best professional judgment were the basis for generation of a list of wetland functions, sub-functions, benefits, and variables for this field-based method. The primary reference source for wetland functional assessments was Bartoldus (1999). The Bartoldus document provides a review of 40 wetland assessment procedures. This list of assessment procedures was augmented with a literature search.

Three wetland functions were identified for use by NC WAM: Hydrology, Water Quality, and Habitat. Each of these primary functions has been sub-divided into sub-functions which vary by general wetland type. The Hydrology function is divided into 1) surface storage and retention, and 2) sub-surface storage and retention. Table 1 provides a list of benefits and characteristic field indicators associated with these sub-functions. The Water Quality function is divided into 1) particulate change, 2) soluble change, 3) pathogen change, 4) physical change, and 5) pollution change. The first four Water Quality sub-functions are considered for riverine wetlands, and the fifth Water Quality sub-function (a combination of components of the first four) is considered for non-riverine wetlands. Table 2 provides a list of benefits, data variables, and characteristic field indicators associated with these sub-functions. The Habitat function is divided into 1) habitat physical structure, 2) landscape patch structure, 3) connectivity, 4) vegetation composition, and 5) uniqueness. Table 3 provides a list of characteristic field indicators associated with these sub-functions.




| WETLAND TYPE | LEVEL III ECOREGION | | | |
|---|---|---|---|---|
| | BLUE RIDGE MOUNTAINS | PIEDMONT | SOUTHEASTERN PLAINS | MIDDLE ATLANTIC COASTAL PLAIN |
| Bottomland Hardwood Forest | X | X | X | X |
| Riverine Swamp Forest | X | X | X | X |
| Headwater Wetland | X | X | X | X |
| Floodplain Pool | X | X | X | X |
| Small-Basin Wetland | X | X | X | X |
| Non-Riverine Swamp Forest | X | X | X | X |
| Mountain Bog | X | - | - | - |
| Seep | X | X | X | X |
| Non-Tidal Freshwater Marsh | X | X | X | X |
| Pocosin | - | - | X | X |
| Hardwood Flat | - | - | X | X |
| Pine Flat | - | - | X | X |
| Pine Savanna | - | - | X | X |
| Tidal Freshwater Marsh | - | - | - | X |
| Salt / Brackish Marsh | - | - | - | X |
| Estuarine Woody Wetland | - | - | - | X |

NC WAM USER MANUAL

## WETLAND TYPE OCCURRENCE BY LEVEL III ECOREGION

Date: October 2006

Figure: 1

**Table 1. Hydrology sub-functions, benefits, data variables, and field indicators**

| Sub-functions | Benefits | Data Variables[1] | Field Indicators |
|---|---|---|---|
| **Surface storage and retention** | Runoff reduction | | Microtopography |
| | Flow velocity reduction | | Vegetation cover |
| | Habitat-related factors | | Overland flow indicators |
| | Energy dissipation | Surrounding land use | Retention time |
| | Stream-flow volume reduction | | Distance to surface water |
| | | | Evidence of overbank flooding |
| | Reduce erosion and sedimentation | Surrounding land use | |
| | Water quality related factors | Proximity to water body | |
| **Sub-surface storage and retention** | Peak flow attenuation | | Microtopography |
| | Stream-flow volume reduction | | Slope |
| | | | Soil texture/profile |
| | Maintenance of baseflow | Soil survey | |
| | Prolonged soil saturation | Soil survey | |
| | Water quality related factors | USGS 7.5-minute topo | |
| | Habitat related factors | | |
| | Moderation of groundwater recharge and discharge | | |

[1] Can be derived from available mapping or Geographic Information Systems (GIS)

## Table 2. Water quality sub-functions, benefits, data variables, and field indicators

| Sub-functions | Benefits | Data variables[2] | Field variables |
|---|---|---|---|
| **Particulate change** | Sediment retention<br>Toxicant reduction<br>Nutrient reduction<br>Carbon export | Surrounding land use<br>Proximity to water body<br>Watershed position<br>Soil type<br>Duration of inundation<br>Wetland type<br>Width perpendicular to stream | Vegetation density<br>Sources of pollutants<br>Retention time<br>Wetland size<br>Soil type<br>Indicators of deposition<br>Open water connectivity |
| **Soluble change** | Sediment reduction (especially TSS[1])<br>Toxicant reduction and transformation<br>Nutrient reduction and transformation<br>Carbon export | Surrounding land use<br>Proximity to water body<br>Watershed position<br>Soil type<br>Duration of inundation<br>Wetland type<br>Width perpendicular to stream | Sources of pollutants<br>Retention time<br>Wetland size<br>Soil type<br>Indicators of deposition<br>Open water connection |
| **Pathogen change** | Bacterial and viral reduction | Surrounding land use<br>Proximity to water body<br>Watershed position<br>Soil type<br>Duration of inundation<br>Wetland type<br>SA[3] class waters<br>Width perpendicular to stream | Sources of pollutants<br>Wetland size<br>Soil type<br>Open water connectivity<br>Residence time |
| **Physical change** | Shoreline stability<br>Temperature moderation | Riparian cover condition<br>Proximity to water body<br>Watershed position<br>Soil type<br>Duration of inundation<br>Wetland type<br>Trout waters<br>Wetland size<br>Width perpendicular to stream | Vegetated buffers<br>Land use<br>Wetland size<br>Wetland type<br>Vegetation density<br>Evidence of erosion |
| **Pollution change** | Nutrient and sediment reduction | Surrounding land use<br>Soil type<br>Duration of inundation<br>Wetland type | Sources of pollutants<br>Retention time<br>Wetland size<br>Soil type<br>Land use |

[1] TSS = Total suspended solids
[2] Can be derived from available mapping or Geographic Information Systems (GIS)
[3] SA = Water classified by N.C. Division of Water Quality for commercial shellfishing

## Table 3. Habitat sub-functions, data variables, and field indicators

| Sub-function | Data Variables[1] | Field Indicators |
|---|---|---|
| **Habitat physical structure** | | Vegetation vertical structure |
| | | Tree size |
| | | Diameter class distribution |
| | | Snags |
| | | Large woody debris |
| | | Water (presence/absence) |
| | | Retention time |
| | | Microtopography |
| | | Canopy gaps |
| | | Vegetation patchiness |
| | | Vegetation density |
| **Landscape patch structure** | Surrounding land use | Edge effect |
| | Surrounding land use | Wetland size |
| | Surrounding land use | Connectivity to other natural habitats |
| | Surrounding land use | Fragmentation |
| | Surrounding land use | Land use |
| **Connectivity** | Surrounding land use | Connected to same wetland type |
| | Proximity to water body | Connected to surface water |
| | Surrounding land use | Land use |
| **Vegetation composition** | | Appropriate vegetation species (natural recruitment) |
| | | Vegetation diversity |
| | | Absence of exotics |
| | | Age-class distribution |
| **Uniqueness** | | Outstanding condition, consistent with reference standard |
| | | Presence of a natural heritage element |
| | | Adjacent/directly connected to a designated area (anadromous fish, shellfish, outstanding resource waters, etc.) |

[1] Can be derived from available mapping or Geographic Information Systems (GIS)

Subsequently, the WFAT generated and refined through field testing, a series of field indicators to be evaluated during a wetland assessment. The field indicators are evaluated by an assessor through questions (or metrics) presented on a Field Assessment Form (see NC WAM forms provided at the beginning of the User Manual [current version 3.13, January 12, 2007]). Due to the broad-based approach of the wetland assessment method, WFAT decided that ratings would be qualitative (High, Medium, and Low) as opposed to quantitative (a specific numerical system). The WFAT believes that assigning a specific value along a numeric continuum of functional significance would greatly exaggerate the accuracy with which current knowledge (and this method) can realistically be applied.

## 2.2 Wetland Condition and Opportunity

It is recognized that direct measurement of wetland function is impractical with the time limitations imposed on this rapid field assessment method. Therefore, NC WAM uses indicators of wetland condition (**condition metrics**) relative to a reference standard (if available) as a surrogate for wetland function. In effect, observed wetland condition is used to infer wetland function. These indicators are more general measures (metrics) of the condition of the subject wetland. A condition metric rates inherent characteristics of a given wetland that affect its ability to perform a given function. Most condition metrics are rated relative to a reference wetland of the same type, but a few condition metrics are used to rate characteristics that naturally vary among wetlands. The condition of a wetland can range from reference (little apparent disturbance, indicating a fully functional wetland) to severely degraded (disturbance has altered a wetland's ability to perform one or more major functions).

An **opportunity metric** rates watershed circumstances affecting the potential of a wetland to perform a given function. In NC WAM, opportunity metrics apply only to metrics used to rate the Water Quality function and address watershed and discharge alterations that increase pollutant inputs to the wetland. If stormwater from a developed/disturbed area is directed away from the wetland, no opportunity is present.

NC WAM recognizes that measures of opportunity for a change in Water Quality function due to circumstances directly or indirectly affecting a wetland may be useful to some regulatory agencies in estimating the level of wetland function. NC WAM utilizes indicators of both condition and opportunity in the generation of Water Quality functional ratings, and condition and opportunity indicators are analyzed independently of each other. NC WAM presents results derived from both indicators for consideration by permitting agencies. The Wetland Rating Sheet provides 1) Water Quality sub-function ratings based on condition metrics only, 2) Water Quality sub-function ratings based on condition metrics as modified by the presence of an opportunity to enhance wetland function in the watershed, and 3) an indication as to whether an opportunity to enhance wetland function is present in the watershed (see NC WAM forms provided at the beginning of the User Manual).

Also brought under consideration during development of NC WAM was the issue of human values. In particular, the WFAT considered whether urban wetlands were undervalued by the proposed approach, and whether an "urban uniqueness" sub-function was needed. Deliberations on this issue resulted in the development of the concept of the aforementioned "opportunity" metrics. Opportunity metrics used in the Water Quality function are expected to help address the issue of undervaluing urban wetlands.

## 2.3 Disturbance and Stressors

The term "disturbance" refers to both natural and anthropogenic activities which may result in alteration to one or more wetland functions. Natural disturbances include, but are not limited to, storm and fire damage, salt-water intrusion (when inappropriate for that wetland type), beaver impoundment, stream migration, and sedimentation. The term "stressor" refers to a typically anthropogenic activity which affects one or more wetland functions by altering the wetland from reference condition. The response of a wetland to a stressor depends on the wetland type, size, and severity of the stressor.

Examples of stressors may include the following (modified from Adamus and Brandt 1990). Wetland functions likely to be affected by each stressor are indicated in parentheses.

- nutrient enrichment/eutrophication (Water Quality, Habitat)
- organic loading and reduced dissolved oxygen (Water Quality, Habitat)
- contaminant toxicity (Water Quality, Habitat)
- acidification (Water Quality, Habitat)
- salinization (Water Quality, Habitat)
- sedimentation/burial (Water Quality, Habitat)
- turbidity/shade (Water Quality, Habitat)
- vegetation removal (Hydrology, Water Quality, Habitat)
- thermal alteration (Water Quality, Habitat)
- dehydration, inundation (Hydrology, Water Quality, Habitat)
- fragmentation of habitat (Hydrology, Water Quality, Habitat)
- soil disturbance (Hydrology, Water Quality, Habitat)

### 2.3.1 Within-Wetland Stressors

The presence of stressors within a wetland is anticipated to always degrade the condition of the wetland. Common stressors located within wetlands and their impact on wetland functions are discussed below.

#### Ditching

Ditching can typically be considered to remove water from a site; however, ditching is more effective if the ditches are connected and transport water off site. In the Coastal Plain ecoregions, ditches are frequently not connected, in which case they provide storage with negligible drainage. Also, depth of ditching may determine the effectiveness of drainage. An

assessor should determine whether ditches are connected and draining an area prior to conducting a wetland assessment.

Effective ditching can degrade all three wetland functions through a reduction in both surface and subsurface storage and retention. Ditching potentially increases flashiness of water volumes draining to downstream surface waters, reduces treatment time for overbank flows and upland runoff, increases the potential for erosion and sedimentation, and degrades wildlife habitat. Also, in the Coastal Plain ecoregions, ditching may provide a conduit for wind-driven saltwater intrusion into freshwater areas.

**Beaver**

Beaver activity may have a substantial effect on all three wetland functions. Whether the effects are considered positive or negative depends on the circumstances. Beaver tend to modify the local plant community composition and structure through flooding and tree cutting. Removal of vegetation may reduce energy dissipation; however, formation of impoundments may provide more storage than was previously available. Impoundments may also act as sinks for water-borne particulates and toxicants, while at the same time reducing a wetland's efficiency at removing water-borne pathogens. The modifications to Hydrology, Water Quality, and vegetation structure and composition combine to change local habitats available to wildlife and aquatic species. A beaver impoundment should not be considered a stressor if it is long-established.

**Vegetation Removal**

Removal of vegetation affects all three wetland functions. Hydrology is affected through the loss of the evapotranspiration mechanism, the loss of structure that can dissipate the energy of surface water, and the loss of structure that can trap sediment. Mechanical clear-cutting may compact surface soils, especially if conducted during the winter wet season. Compaction of surface soils increases potential for surface scour and reduces infiltration. Water Quality is affected since removal of vegetation reduces the wetland's ability to moderate surface water temperatures, slow and hold flood flows, and sequester excess nutrients and toxicants. Removal of vegetation, along with the associated ground disturbance, removes food and habitats for all fauna (arboreal, ground dwelling, and fossorial).

**Livestock**

Livestock operations may negatively affect all three wetland functions. Removal of wetland/riparian vegetation through grazing may increase erosion, reduce energy dissipation, reduce surface water shading, reduce available habitats, and degrade water quality. The presence of livestock is also expected to result in soil compaction, thereby increasing runoff rates and flow velocity and decreasing sub-surface storage. Livestock manure is a discharge and should be considered a pollutant.

### 2.3.2 Watershed Stressors

The presence of stressors within the watershed draining to the wetland is considered by some regulatory agencies to provide opportunity to enhance components of the wetland's Water Quality function – but only if the stressors are not overwhelming the treatment capacity of the wetland. Water Quality sub-functions potentially enhanced due to the presence one or more stressors in the watershed include Physical Change (dissipation of energy), Particulate Change (retention of increased loads of sediment and particle-sized toxicants), Soluble Change (retention of increased loads of total suspended solids and suspended toxicants and nutrients), Pathogen Change (retention of and reduction of increased loads of bacteria and viruses), and Pollution Change (retention of increased loads of sediment, toxicants, and nutrients). See Section 2.2 for a brief discussion of wetland condition and opportunity.

## 3.0 WETLAND CLASSIFICATION SYSTEM

### 3.1 General Wetland Types

NC WAM recognizes 16 general wetland types for North Carolina.

- Bottomland Hardwood Forest
- Riverine Swamp Forest
- Headwater Wetland
- Floodplain Pool
- Pocosin
- Hardwood Flat
- Pine Flat
- Pine Savanna
- Small-Basin Wetland
- Non-Riverine Swamp Forest
- Mountain Bog
- Seep
- Non-Tidal Freshwater Marsh
- Tidal Freshwater Marsh
- Salt/Brackish Marsh
- Estuarine Woody Wetland

The purpose of specifying general wetland types is to 1) provide a unified list of wetland types for North Carolina, 2) account for impacts by wetland type, and 3) account for the inherent differences in function for each wetland type. The general wetland types are a consolidation of wetland types previously defined by the NCNHP in *Classification of the Natural Communities of North Carolina: Third Approximation* (Schafale and Weakley 1990), NCDWQ in *A Field Guide to North Carolina Wetlands* (NCDEM 1996), NCDCM in *DCM Wetland Mapping in Coastal North Carolina* (Sutter 1999), and USACE in HGM (Brinson unpublished). NCNHP classified North

Carolina wetlands into 59 types, NCDWQ classified North Carolina wetlands into 14 types, NCDCM classified Coastal Plain (physiographic province) wetlands into 13 types, and HGM currently recognizes five wetland classes. It should be noted that since the resulting grouping of general wetland types in NC WAM is a consolidation of types defined by these sources, definitions may overlap to some extent. A table cross-referencing NC WAM, NCNHP, NCDCM, and HGM wetland types is provided in Appendix B.

The WFAT also generated a list of four non-wetland open water types: natural waterbodies, artificial waterbodies, estuarine waters, and ocean. A method of functional assessment has not been generated for these open water types, and these open water types will not be discussed in this manual.

Some general guidance regarding the narrative descriptions of the general wetland types follows. References to inundation pertain to inundation during the growing season. Figure 1 depicts boundaries of North Carolina level III ecoregions (while Appendix F depicts boundaries of the Sand Hills level IV ecoregion [the term “Sandhills” is used in this document]) and provides tables of the occurrence of general wetland types by ecoregion. Vascular plant names follow nomenclature found in Weakley (2006) or Radford et al. (1968).

### 3.1.1 Bottomland Hardwood Forest

3.1.1-1


3.1.1-2

Photo 3.1.1-1 and Photo 3.1.1-2 are examples of Bottomland Hardwood Forest. Photo 3.1.1-1 is located in the Swift Creek floodplain, Wake County; and Photo 3.1.1-2 depicts the Little Creek floodplain at the headwaters of Jordan Lake, Durham County.

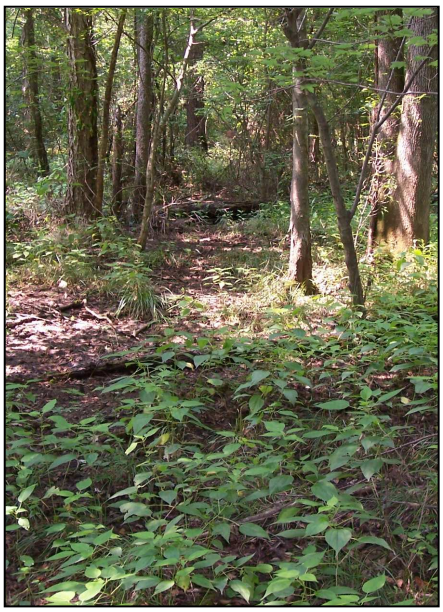
Bottomland Hardwood Forests are found throughout the state in floodplains of second-order (Strahler 1952) and larger (typically perennial) streams and rivers (see Appendix C for a schematic to assist with stream order determinations). These wetlands are generally intermittently to seasonally inundated for long duration. Overbank flooding can be an important source of water as can be groundwater and surface runoff. Overbank flooding may be less influential for Bottomland Hardwood Forests west of the Middle Atlantic Coastal Plain ecoregion. Bottomland Hardwood Forests along brownwater streams receive more sediment and nutrients from overbank flooding than those found along blackwater streams. Bottomland Hardwood Forests generally occur on mineral soils. This wetland type is dominated by a variety of hardwood tree species including various oaks (*Quercus* spp.), red maple (*Acer rubrum*), ashes (*Fraxinus* spp.), sycamore (*Platanus occidentalis*), sweetgum (*Liquidambar styraciflua*), box elder (*Acer negundo*), hackberry (*Celtis laevigata*), and American elm (*Ulmus americana*).

Reference wetlands (see Section 3.2) are available for Bottomland Hardwood Forest, but vary widely in character among different floodplain sizes and the various regions of the state. The size and extent of these wetlands are dependent on floodplain size and disturbance. While smaller-order streams will typically support narrower wetlands, these wetlands may be extensive along the length of the floodplain. Bottomland Hardwood Forests may contain Floodplain Pools and may transition up slope to Headwater Wetland and down slope to Riverine

Swamp Forest. In the Coastal Plain ecoregions, Bottomland Hardwood Forests often occur in extensive mosaics with Riverine Swamp Forest.

Bottomland Hardwood Forest correlates to the NCNHP types Coastal Plain Bottomland Hardwoods (Blackwater and Brownwater Subtypes), Coastal Plain Levee Forest (Blackwater and Brownwater Subtypes), Piedmont/Mountain Levee Forest, Piedmont/Mountain Bottomland Forest, Montane Alluvial Forest, and part of Piedmont/Low Mountain Alluvial Forest. Bottomland Hardwood Forest is included in the NCDCM wetland type of Bottomland Hardwood Forest. Bottomland Hardwood Forest corresponds to the HGM class Riverine (sub-classes Intermittent–Upper Perennial, Lower Perennial, and Headwater Complex).


3.1.1-3



3.1.1-4

Photo 3.1.1-3 and Photo 3.1.1-4 are more examples of Bottomland Hardwood Forest in Wake County. Photo 3.1.1-3 depicts a recently clear-cut portion of the Swift Creek floodplain, and Photo 3.1.1-4 depicts the outer edge of a floodplain to an unnamed tributary to Little Branch.

### 3.1.2 Riverine Swamp Forest

3.1.2-1

3.1.2-2

These examples of Riverine Swamp Forest depict the Broomfield Swamp floodplain, Beaufort County (3.1.2-1) and an unnamed tributary in the Green Swamp, Brunswick County (3.1.2-2).

Riverine Swamp Forests are found throughout the state, but are most extensive and abundant in the Coastal Plain ecoregions. This wetland type is found in the wettest portions of the floodplains of major rivers and other permanent water bodies including linear depressions that lead to stream systems, tidally-influenced lower river reaches (primarily freshwater, but also brackish water in the upper reaches of estuaries), and along the shorelines of large lakes (20 acres or larger in size). Riverine Swamp Forests are seasonally to semi-permanently inundated for very long duration and occur on mineral or organic soils. Overbank or tidal flooding is usually an important source of water, but groundwater and surface runoff are also important. Seasonal fluctuations in lake levels may mimic the seasonal flooding of rivers. Lakes larger than 20 acres may provide enough fetch for effective wind tides, approximating overbank flooding as experienced in floodplains. Vegetation is most often dominated by mesic and hydrophytic tree species such as overcup oak (*Quercus lyrata*), ashes, and American elm in the Piedmont and Blue Ridge Mountains ecoregions and bald cypress (*Taxodium distichum*), black gum (*Nyssa biflora*), and water tupelo (*N. aquatica*) in the Coastal Plain ecoregions. In estuaries, lower reaches of rivers, and along the shorelines of large lakes, Riverine Swamp Forest can be distinguished from marshes by having greater than 50 percent coverage of woody vegetation.

Reference wetlands (see Section 3.2) are available for this type. The size of this community varies widely from narrow strips of backwater at the toe of floodplain slopes to broad expanses extending for hundreds of acres. Riverine Swamp Forests may transition upslope to Bottomland Hardwood Forest and Headwater Wetland and downslope to Tidal Freshwater Marsh, Salt/Brackish Marsh, and Estuarine Woody Wetland.

Riverine Swamp Forest corresponds to NCNHP types Cypress–Gum Swamp (Blackwater and Brownwater Subtypes), Coastal Plain Small Stream Swamp (part), Piedmont/Mountain Swamp Forest, Tidal Cypress–Gum Swamp, and Natural Lake Shoreline (part). Riverine Swamp Forest is included in the NCDCM wetland type of Swamp Forest. Riverine Swamp Forest corresponds to the HGM classes Riverine (sub-classes Lower Perennial and Headwater Complex), Lacustrine Fringe (sub-class Semi-permanently Flooded), and Estuarine Tidal Fringe (subclass Estuarine Wind Intertidal).


3.1.2-3


3.1.2-4

3.1.2-5

These examples of Riverine Swamp Forest are a beaver-impacted portion of the Mingo Creek floodplain, Wake County (3.1.2-3); the headwaters of Robertson's Millpond on Buffalo Creek, Wake County (3.1.2-4); and Town Creek (lunar tides), Brunswick County (3.1.2-5).

3.1.2-6

3.1.2-7

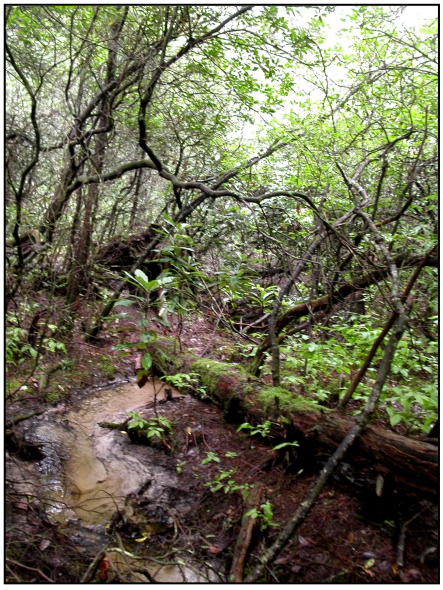
These examples of Riverine Swamp Forest are located in the headwaters of Huddle's Cut, Beaufort County (3.1.2-6); along the Pungo Lake shoreline (wind tides), Washington County (3.1.2-7); in Deep Creek, a broad linear feature with no readily identifiable channel, Washington County (3.1.2-8); and along the eastern shore of the Alligator River (subject to wind tides and wave action), Dare County (3.1.2-9).

301.2-8

3.1.2-9

### 3.1.3 Headwater Wetland

3.1.3-1

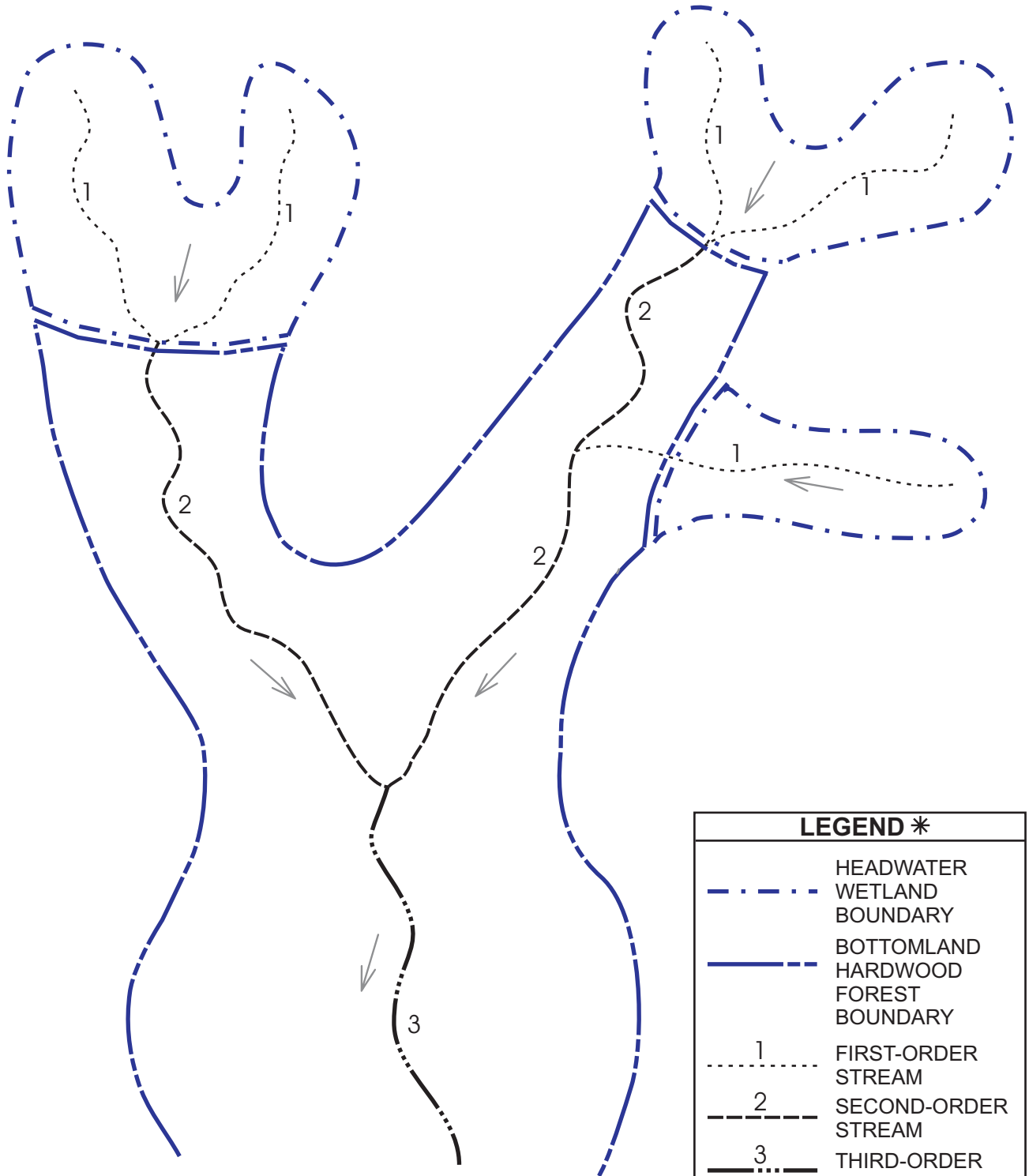


3.1.3-2

These examples of Headwater Wetland are located in upper Porter Creek, Beaufort County (3.1.3-1) and along a first-order tributary to the South Fork of the French Broad River, Transylvania County (3.1.3-2).

"Headwater wetland" is not an exclusive term. Other wetland types can behave as headwaters; however, NC WAM utilizes this name for one of the 16 general wetland types in North Carolina. Headwater Wetlands are found throughout the state along headwater streams. For the purposes of NC WAM, headwater streams are typically defined as zero- (i.e., not shown) to first-order streams as shown on the most recent version of the 1:24,000 USGS topographic map (see Appendix C for a schematic to assist with stream order determinations). Furthermore, these streams are typically ephemeral or intermittent. Headwater Wetlands may be associated with second- or third-order streams in the Sandhills ecoregion of North Carolina. In the Piedmont and Blue Ridge Mountains ecoregions, if a soil survey indicates that a floodplain is not underlain by Chewacla soils, the floodplain is likely associated with a lower-order stream and may be a candidate for supporting Headwater Wetlands. See Figure 2 for an example of how to delineate the difference between a Headwater Wetland and a Bottomland Hardwood Forest at the confluence of a first-order stream and a second-order stream outside of the Sandhills.

Groundwater seepage and diffuse surface flow are often important sources of water, and this wetland type frequently has surface flow, especially through ephemeral channels. Overbank flooding is not a substantial source of water, and Headwater Wetlands are relatively dry when compared to other riverine wetland types. Headwater Wetlands generally occur on mineral soils that are irregularly inundated by surface water, seasonally saturated, or subject to




✳**Sandhill Headwater Wetlands may occur on higher than first-order streams.**

NC WAM USER MANUAL

**HEADWATER WETLAND / BOTTOMLAND HARDWOOD FOREST STREAM-ORDER BOUNDARY DETERMINATION**

AUGUST 2006

FIGURE

2

long-term saturation. Wetlands adjacent to small streams in the Piedmont and Blue Ridge Mountains ecoregions that are not on soils mapped as Chewacla, are likely Headwater Wetlands rather than Bottomland Hardwood Forests. Hardwood tree (examples: swamp chestnut oak [*Quercus michauxii*], hackberry [*Celtis laevigata*], sycamore [*Platanus occidentalis*], green ash [*Fraxinus pennsylvanica*], red maple [*Acer rubrum*], American hornbeam [ironwood – *Carpinus caroliniana*], tulip-tree [*Liriodendron tulipifera*], and American elm [*Ulmus americana*]) and shrub species (examples: American holly [*Ilex opaca*], silky dogwood [*Cornus amomum*], and spicebush [*Lindera benzoin*]) are the predominant vegetation, except in the Sandhills, where pond pine (*Pinus serotina*) or Atlantic white cedar (*Chamaecyparis thyoides*) may be present and/or dominant.

Reference wetlands (see Section 3.2) are available for this type, but vary in characteristics among ecoregions. The size of Headwater Wetlands may vary depending on hydrology, topography, and ecoregion. Headwater Wetlands can gradually grade into other wetland types making their identification problematic. For instance, a wetland located on an intermittent or ephemeral stream is usually a Headwater Wetland. Wetlands located in bottomlands and floodplains, even when the main channel is not the main source of water for the wetland, usually will be classified as either a Bottomland Hardwood Forest or Riverine Swamp Forest, depending on the stream size and hydrologic regime. Finally, Headwater Wetlands in the Sandhills ecoregion are often associated with streams where there is no well-developed floodplain and overbank flooding is not common due to the high porosity of the soil. In this landscape position, Headwater Wetlands may have the vegetation components of Pocosins.

3.1.3-3

3.1.3-4

These examples of Headwater Wetland are located near a stormwater outlet along a first-order tributary to Hominy Creek, Buncombe County (3.1.3-3) and in a beaver-impacted, first-order tributary to Milburnie Lake, Wake County (3.1.3-4).

Headwater Wetlands correspond to NCNHP types Piedmont Alluvial Forest, Coastal Plain Small Stream Swamp (part), Streamhead Atlantic White Cedar Forest, and Streamhead Pocosin. This type is included in the NCDCM wetland type of Headwater Forest. Headwater Wetland corresponds to the HGM classes Riverine (sub-class Intermittent–Upper Perennial, Headwater Complex) and Slope (sub-class Mineral Soil).

### 3.1.4 Floodplain Pool

3.1.4-1


3.1.4-2

These examples of Floodplain Pool are located in the floodplain of Ready Branch of Sweetwater Creek, Martin County (3.1.4-1); the floodplain of Swift Creek at Hemlock Bluffs Nature Preserve, Wake County (3.1.4-2); and the floodplain of Speight Branch, Wake County (3.1.4-3).


3.1.4-3

Floodplain Pools are found throughout the state in geomorphic floodplains of streams and rivers. These wetlands often occur in abandoned stream or river channels (oxbows) or in localized depressions near the toe of slopes. They are generally small in size and are semi-permanently to permanently inundated. Sources of water are primarily ground water, rain water,

and sometimes overbank flooding. A distinctive feature of Floodplain Pools is that they usually dry out at some point of the year and thereby provide important habitat for amphibians due to the lack of fish communities. Trees characteristic of wetland and upland floodplains and levees are commonly found around the edge of the pool rather than growing within the pool. Vegetation within the pool can be sparse or variable with a variety of ferns, sedges, and other herbaceous plants present.

Reference wetlands (see Section 3.2) are available for this type. Floodplain Pools can transition to Bottomland Hardwood Forest and Riverine Swamp Forest or may be surrounded by uplands. As stated above, Floodplain Pools are generally small in size.

Floodplain Pool corresponds to the NCNHP type of Floodplain Pool. This wetland type is not separately identified within the NCDCM wetland classification system. Floodplain Pool corresponds to the HGM classes Riverine (sub-class Headwater Wetland) and Depression (sub-classes Surface-connected and Isolated Groundwater).

### 3.1.5 Pocosin


3.1.5-1


3.1.5-2

These examples of Pocosin are both from Brunswick County. Photo 3.1.5-1 depicts the low pocosin sub-type; and Photo 3.1.5-2 depicts the high pocosin subtype.

Pocosins are found in the Coastal Plain ecoregions on poorly drained, inter-stream flats and in basins of various sizes such as peat-filled Carolina bays. Pocosins can be seasonally saturated or inundated by a high or perched water table. The primary source of water is a high water table resulting from precipitation and slow drainage, but, rarely, Pocosins are found adjacent to surface waters. Pocosins occur on mineral or organic soils. Vegetation is dominated by dense, waxy evergreen shrubs that typically include gallberries (*Ilex* spp.), fetterbushes (*Leucothoe* spp.), honey-cup (*Zenobia pulverulenta*), and bamboo-vine (greenbrier – *Smilax laurifolia*) often mixed with pond pine (*Pinus serotina*) and evergreen hardwoods such as loblolly bay (*Gordonia lasianthus*), swamp bay (*Persea palustris*), and sweet bay (*Magnolia virginiana*).

Pocosin vegetation structure may take a variety of forms, resulting in the need for the assessor to be familiar with multiple sub-type reference wetlands (see Section 3.2) (see corresponding NCNHP wetland types below). Pocosins may transition to a variety of wetland types depending on topography, hydrologic regime, and disturbance including Non-Riverine Swamp Forest, Pine Savanna, Pine Flat, Hardwood Flat, Riverine Swamp Forest, Salt/Brackish Marsh, Non-Tidal Freshwater Marsh, and Estuarine Woody Wetland. Areas of this wetland type vary greatly in size dependent on landscape position. The extent of the wetland type may not be apparent in the field or with the use of aerial photography due to past disturbance; however, soils mapping may prove useful in determining the potential extent of Pocosin prior to disturbance. Appendix D contains a list, compiled by NCDCM, of soils that are known to typically support Pocosin. This list is not considered to be all inclusive or absolute, but rather a guide for the assessor to use when estimating the original aerial extent of a Pocosin.

Pocosin comprises NCNHP types Low Pocosin, High Pocosin, Pond Pine Woodland, Small Depression Pocosin, and Bay Forest. Pocosins are included in the NCDCM wetland type of Pocosin along with some of the Pine Flat wetland type if it is dominated by pond pine. Pocosin corresponds to the HGM classes Flat (sub-classes Mineral Soil and Organic Soil) and Depression (sub-class Isolated Groundwater).


3.1.5-3

3.1.5-4

These examples of Pocosin are intensively managed within a power line corridor, Brunswick County (3.1.5-3); upslope of an Estuarine Woody Wetland on Roanoke Island, Dare County (3.1.5-4); a pond pine woodland dominated by pond pine and loblolly bay in Alligator River National Wildlife Refuge, Dare County (3.1.5-5); and a Carolina bay in southeastern North Carolina (3.1.5-6) (photograph courtesy George A. Howard).

3.1.5-5

3.1.5-6

### 3.1.6 Hardwood Flat

3.1.6-1

3.1.6-2

These examples of Hardwood Flat are located south of the Pamlico River, Beaufort County (3.1.6-1); north of Phelps Lake, Washington County (this wetland had recently suffered storm damage from Hurricane Isabel) (3.1.6-2); and near the community of East Lake, Dare County (3.1.6-3).

3.1.6-3

Hardwood Flats are found primarily in the Coastal Plain ecoregions on poorly drained, inter-stream flats. These areas are usually seasonally saturated or intermittently to seasonally inundated by a high water table or poor drainage, but have a shorter hydroperiod than Non-Riverine Swamp Forests. The primary source of water is a high water table resulting from precipitation and overland runoff. Hardwood Flats generally occur on mineral soils. These systems are dominated by hardwood tree species including various oaks (examples: swamp chestnut oak [*Quercus michauxii*], laurel oak [*Q. laurifolia*], and cherrybark oak [*Q. pagoda*]) and sweetgum (*Liquidambar styraciflua*).

Reference wetlands (see Section 3.2) are available for this type. This wetland type may vary widely in size, but can be quite large, dependent on landscape position and disturbance. Hardwood Flat can transition to Pocosin, Pine Savanna, Pine Flat, and Non-Riverine Swamp Forests on interstream flats and can transition to Headwater Wetland at the upper extent of drainage slopes.

Hardwood Flat comprises the NCNHP types Non-Riverine Wet Hardwood Forest, Wet Marl Forest, and successional forests in similar landscape positions. Hardwood Flats are included in the NCDCM wetland type of Hardwood Flats. Hardwood Flat corresponds to the HGM class Flat (sub-class Mineral Soil).

### 3.1.7 Pine Flat

3.1.7-1

3.1.7-3

3.1.7-2

These examples of Pine Flat are south of the Pamlico River, Beaufort County (3.1.7-1); east of Havelock, Craven County (3.1.7-2); and south of US 64, Tyrrell County (3.1.7-3).

Pine Flats are found primarily in the Coastal Plain ecoregions on poorly drained inter-stream flats. These areas are usually seasonally saturated or intermittently to seasonally inundated by a high water table or poor drainage. The primary source of hydrology is a high water table resulting from precipitation and overland runoff. Pine Flats generally occur on mineral soils. This wetland type may be dominated by forest, early successional forest/shrub, or managed pine plantation. Common canopy trees are pines including loblolly (*Pinus taeda*) and slash pine (*P. elliottii*), and may include a large component of red maple (*Acer rubrum*) and sweetgum (*Liquidambar styraciflua*). The shrub component is typically not dense and may include horsesugar (*Symplocos tinctoria*), American holly (*Ilex opaca*), swamp bay (*Persea palustris*),

coastal white alder (sweet pepperbush – *Clethra alnifolia*), and common wax-myrtle (*Morella cerifera*).

Almost all Pine Flats are successional in nature and represent altered variants of the Pine Savanna, Hardwood Flat, or Non-Riverine Swamp Forest; therefore, there are no reference wetlands for this type (see Section 3.2). This wetland type is typically managed and is often characterized by low species diversity and structural complexity, which decreases the Habitat function of this wetland. Pine Flats may vary widely in size, but can be quite large, dependent on landscape position and disturbance. Pine Flats can transition to Pocosin, Pine Savanna, Hardwood Flat, and Non-Riverine Swamp Forests on interstream flats and can transition to Headwater Wetland at the upper extent of drainage slopes.

This wetland type has no NCNHP counterpart, but includes disturbed variants of several types of non-alluvial forests such as Nonriverine Wet Hardwood Forest, Nonriverine Swamp Forest, Wet Pine Flatwoods, and Pine Savanna. Pine Flat is included in the NCDCM wetland type of Pine Flat and Managed Pineland. Pine Flat corresponds to the HGM class Flat (sub-class Mineral Soil).

### 3.1.8 Pine Savanna


3.1.8-1


3.1.8-2

These examples of Pine Savanna are both from Brunswick County and are located within the Military Ocean Terminal, Sunny Point (3.1.8-1) and along NC 211 in the Green Swamp (3.1.8-2).

Pine Savannas are found in the Coastal Plain ecoregions on poorly drained, inter-stream flats. These areas are usually seasonally saturated by a high water table or poor drainage, but have a shorter hydroperiod than Non-Riverine Swamp Forest. The primary sources of water are a high water table resulting from precipitation and overland runoff. Pine Savannas are maintained by frequent, low-intensity fires and occur on mineral soils. This wetland type is dominated by long-leaf (*Pinus palustris*) and pond pine (*P. serotina*), with scattered, low shrubs such as little gallberry (*Ilex glabra*), creeping blueberry (*Vaccinium crassifolium*), common wax-myrtle (Morella cerifera), and dangleberry (*Gaylussacia frondosa*) (Schafale and Weakly 1990) and grassy ground cover (dominated by grasses, sedges, composites, orchids, and lilies (Schafale and Weakely 1990) in reference condition. Regular burns provide conditions for very high herb species diversity.

Reference wetlands (see Section 3.2) are available for this type; the few examples remaining in North Carolina are located primarily in the southeastern portion of the state. Size of this wetland type is dependent on long-term fire frequency. Pine Savannas can transition to Pocosin and Pine Flat.

Pine Savanna corresponds to NCNHP types Wet Pine Flatwoods and Pine Savannas. Pine Savannas are included in the NCDCM wetland type of Pine Flats. Pine Savanna corresponds to the HGM class Flat (sub-class Mineral Soil).

### 3.1.9 Small-Basin Wetland

3.1.9-1


3.1.9-2

These examples of Small-Basin Wetland are a mafic depression on an interstream divide, Mecklenburg County (3.1.9-1) and a post hurricane scour pool on Ocracoke Island, Hyde County (3.1.9-2).

Small-Basin Wetlands occur throughout the state outside of geomorphic floodplains and not associated with linear conveyances in depressions surrounded by uplands (usually on inter-stream flats or in localized depressions). This wetland type may also occur on the fringes of small water bodies (less than 20 acres in size). Wetlands fringing larger water bodies are subject to hydrology more closely matching riverine conditions and are therefore considered Riverine Swamp Forest or Non-Tidal Freshwater Marsh. The size threshold used to determine small versus large water bodies was taken from Cowardin et al. (1979). Small-Basin Wetlands are seasonally to semi-permanently inundated but may lose surface hydrology during later portions of the growing season. Sources of water are perched groundwater, groundwater discharge, overland runoff, and precipitation. Seasonal waterlines are often apparent on the vegetation. Small-Basin Wetlands generally occur on mineral soils. Small-Basin Wetlands may be characterized by a variety of mineral soil types ranging in particle size and type from sandy soils associated with Coastal Plain lime sinks to clay-based soils underlying mafic depressions. Vegetation structure within this wetland type may vary widely from forest in mafic depressions and ephemeral pools, to primarily herbaceous or emergent in lime sinks, man-excavated depressions, and along the shorelines of small bodies of water.

Reference wetlands (see Section 3.2) are available for some forms of this wetland type, but since this wetland type is so heterogeneous, an assessor must recognize that an appropriate reference must be considered on a case-by-case basis. Non-reference Small-Basin Wetlands

are rare and most frequently include the wetland edges of excavated farm ponds. Small-Basin Wetlands vary in size based on the variable landscape positions that they may occupy. This wetland type is generally surrounded by uplands, but may occasionally transition to Pine Savanna, Pocosin, or Pine Flats.

Small-Basin Wetland comprises NCNHP types Vernal Pool, Cypress Savanna, Upland Depression Swamp Forest, Upland Depressional Pond, Inner Dune Pond, and Upland Pool. This wetland type is not separately identified in the NCDCM methodology, but would likely be included in the Swamp Forest (non-riverine) and Freshwater Marsh in some cases. Small-Basin Wetland corresponds to the HGM class Depression (sub-classes Isolated Groundwater, Isolated Precipitation, and Human Impounded or Excavated).

3.1.9-3

3.1.9-4

These examples of Small-Basin Wetland are an aquatic emergent-dominated limesink pond (3.1.9-3) and a grass and sedge-dominated limesink pond (3.1.9-4), both located within Carolina Beach State Park, New Hanover County.

### 3.1.10 Non-Riverine Swamp Forest


3.1.10-1

3.1.10-2

These examples of Non-Riverine Swamp Forest are within an inter-dune swale on Bogue Banks, Carteret County (3.1.10-1); in a hurricane-damaged area west of Phelps Lake, Washington County (3.1.10-2); in Buckridge Estuarine Reserve in southeastern Tyrrell County (3.1.10.3); and between US 64 and the Albemarle Sound in northern Tyrrell County (3.1.10-4).

3.1.10-3

3.1.10-4

Non-Riverine Swamp Forest occurs primarily in the embayed region, the northeastern Middle Atlantic Coastal Plain ecoregion, on poorly drained, inter-stream flats not associated with streams, rivers, or estuaries. This wetland type is seasonally to semi-permanently saturated or

inundated with hydrology driven by groundwater discharge, overland runoff, and/or precipitation rather than overbank or tidal flooding. This wetland type occurs on mucky mineral or organic soils. Non-Riverine Swamp Forests are typically characterized by forest vegetation, often dominated by bald cypress (*Taxodium distichum*), black gum (*Nyssa biflora*), and Atlantic white cedar (*Chamaecyperis thyoides*) as well as other tree species, especially in successional stages.

Reference wetlands (see Section 3.2) are available for this type. This wetland type varies in size, but may be quite extensive in the northeastern Middle Atlantic Coastal Plain ecoregion. Non-Riverine Swamp Forest transitions to Pocosin, Hardwood Flat, or Pine Flat with decreasing wetness and to Riverine Swamp Forest in proximity to riverine or tidal systems and large water bodies (greater than 20 acres in size, Cowardin et al. 1979).

Non-Riverine Swamp Forest includes NCNHP types Nonriverine Swamp Forest, Peatland Atlantic White Cedar Forest, Maritime Swamp Forest, and Maritime Shrub Swamp. This wetland type is included in the NCDCM wetland type of Swamp Forest and Maritime Forest on coastal islands. Non-Riverine Swamp Forest corresponds to HGM classes Depression (sub-classes Isolated Groundwater and Isolated Precipitation) and Flat (sub-classes Organic Soil and Mineral Soil).

### 3.1.11 Mountain Bog

3.1.11-1


3.1.11-2

These examples of Mountain Bog are located on a tributary to Cranberry Creek, Avery County (3.1.11-1) and in the Pink Beds on a tributary to the South Fork Mills River, Transylvania County (3.1.11-2).

Mountain Bogs are typically found in the Blue Ridge Mountains and Northern Inner Piedmont ecoregions (Appendix F). This wetland type is associated with floodplains or linear conveyances and is typically located on flat or gently sloping ground. Mountain Bogs are formed by a poorly understood combination of groundwater seepage and/or blocked overland runoff. This wetland type is semi-permanently to permanently saturated, but typically not inundated. Mountain Bogs occur on organic or mucky mineral soils, and this is a key feature in distinguishing bogs from other wetland types. This wetland type is generally transitional in nature and may therefore be found in many forms, from forested to lacking canopy trees, and with sparse ground cover to dense mats of moss and herbs. Bogs are frequently impacted by beaver, and if beaver activity causes long-term inundation, areas formerly supporting Mountain Bog may transition to Non-Tidal Freshwater Marsh.

Although sphagnum moss (*Sphagnum* spp.) is commonly present in Mountain Bogs, it does not occur in all Mountain bogs. In general, vegetation structure may vary, but typically occurs as two forms: 1) dominated by dense herbaceous or mixed shrub/herbaceous vegetation with herbs consisting of small, grass-like plants and forbs with or without tree canopy and 2) tree cover over much of the wetland area and dense herb cover limited to small openings. Indicative herbaceous species include sphagnum moss, various sedges – upright sedge (*Carex stricta*), nodding sedge (*C. gynandra*), prickly bog sedge (*C. atlantica*), bristlystalked sedge (*C.*

*leptalea*), three seeded sedge (*C. trisperma*), long sedge (*C. folliculata*), and Collins sedge (*C. collinsii*) – cinnamon fern (*Osmunda cinnamomea*), royal fern (*O. regalis*), melic mannagrass (*Glyceria melicaria*), roundleaf goldenrod (*Solidago patula*), white beaksedge (*Rhynchospora alba*), Pennsylvania rush (*Juncus gymnocarpus*), woodland rush (*J. subcaudatus*), various pitcher-plants – purple pitcher-plant (*Sarracenia purpurea*), Jones' pitcher-plant (*S. jonesii*), and green pitcher-plant (*S. oreophila*) – smooth sawgrass (*Cladium mariscoides*), and cotton grass (*Eriophorum virginicum*). Indicative shrub species include possumhaw (*Viburnum nudum*), northern wild raisin (*V. cassinoides*), tag alder (*Alnus serrulata*), swamp rose (*Rosa palustris*), winterberry (*Ilex verticillata*), long-stalked holly (*I. collina*), and Canada yew (*Taxus canadensis*).

Reference wetlands (see Section 3.2) are available for this type but, due to the variability of vegetation structure found in bogs, an assessor must recognize the proper reference type. This wetland type is typically limited in size by the availability of flat, wet sites in the Blue Ridge Mountains and western Piedmont ecoregions. Mountain Bogs can transition downstream to Headwater Wetlands, Bottomland Hardwood Forest, or Non-Tidal Freshwater Marsh or may be surrounded by non-jurisdictional bottomlands or uplands.

Mountain Bog includes NCNHP types Southern Appalachian Bog (Northern and Southern Subtypes), Southern Appalachian Fen, and Swamp Forest–Bog Complex (Typic and Spruce Subtypes). This type is not separately identified with the NCDCM wetland mapping since this wetland type is not found in the Coastal Plain ecoregions. Mountain Bog corresponds to HGM classes Depression (sub-classes Isolated Groundwater and Isolated Precipitation) and Flat (sub-classes Organic Soil and Mineral Soil).

3.1.11-3


3.1.11-4

These examples of Mountain Bog are located on a tributary to Price Creek, Watauga County (3.1.11-3) and at Franklin Bog on Blyths Mill Creek, Henderson County (3.1.11-4).

### 3.1.12 Seep

3.1.12-1

3.1.12-2

These examples of Seep are located on a slope outside of the floodplain of an unnamed tributary to Little River, Wake County (3.1.12-1) and on a mountain slope near Deep Gap, Watauga County (3.1.12-2). The source of wetland hydrology in both examples is groundwater expressing to the surface over bedrock.

Seeps are located throughout the state where groundwater is discharged to the surface on a slope outside of a geomorphic floodplain and not in association with a linear conveyance. Wetlands of this type usually occupy small areas on sloping hillsides and are semi-permanently to permanently saturated by ground water on mineral or organic soils. This wetland type typically does not have surface flow (channels), but is usually saturated to the surface. Vegetation in Seeps is quite variable. Depending on size, vegetation of Seeps in the Piedmont and Blue Ridge Mountain ecoregions may be zoned, with open interiors characterized by sparse to dense wetland herbs and a forested outer edge. This wetland type may be small enough to be shaded by adjacent trees. Vegetation structure in the Coastal Plain ecoregions is dependent on fire regime and may vary from dense to sparse growth of shrubs.

Reference wetlands (see Section 3.2) are available for this type. Because this type is very heterogeneous, care will be needed to select the appropriate reference, which will vary by ecoregion and site conditions. Seeps are typically small relative to other general wetland types, but may be larger in the Sandhills ecoregion and in the higher mountains. Seeps can transition to Headwater Wetlands, Bottomland Hardwood Forest, Riverine Swamp Forest, Pine Flat, and Mountain Bog.

Seep includes the NCNHP types Low Elevation Seep, High Elevation Seep, Sandhill Seep, and Hillside Seepage Bog. This wetland type is not separately identified with the NCDCM wetland classification system. Seep corresponds to the HGM class Slope (sub-classes Organic Soil and Mineral Soil).

### 3.1.13 Non-Tidal Freshwater Marsh

3.1.13-1

3.1.13-2

These examples of Non-Tidal Freshwater Marsh are located on a beaver impounded oxbow of the North Fork Mills River, Henderson County (3.1.13-1) and a beaver-impounded reach of a tributary to the Rocky River, Cabarrus County (3.1.13-2).

Non-Tidal Freshwater Marshes are found throughout the state in floodplains, along linear conveyances, in headwaters, and along shorelines of large water bodies (greater than 20 acres in size, Cowardin et al. 1979). These wetlands are subject to inundation or saturation for extended periods during the growing season, but are not subject to regular or occasional flooding by tides, including wind tides (regardless of whether or not the tidal waters reach the marshland areas through natural or artificial watercourses). Non-Tidal Freshwater Marshes occur on mineral or organic soils. Vegetation within this wetland type is predominantly herbaceous (less than 50 percent coverage by living woody species). Appendix E provides a list of vegetation species typically found in saturated (non-emergent) versus inundated (emergent and submergent [aquatic]) representatives of Non-Tidal Freshwater Marsh.

Due to the transitional nature of this wetland type, reference wetlands are not available for this type (see Section 3.2). Since this general wetland type has no reference, the condition of Non-Tidal Freshwater Marshes may be difficult for an assessor to discern. Indicators of condition degradation within this wetland type may include dead vegetation, ditching, spoil piles, reduced size, lack of vegetation diversity, and presence of invasive species. The size of these marshes varies depending on landscape position from very small to rarely 50 acres or more. Non-Tidal Freshwater Marshes can transition to other riverine wetlands such as Bottomland Hardwood Forest, Riverine Swamp Forest, and Headwater Wetland.

Non-Tidal Freshwater Marshes may occur naturally along the fringes of streams, rivers, and large lakes. These wetlands also commonly occur in association with impoundments, whether man-made (examples: fringes of streams and rivers, maintained utility line corridors) or natural

(example: beaver impoundments). Other wetland types with similar hydroperiods (Riverine Swamp Forest, Non-Riverine Swamp Forest, Seeps) may acquire marsh-like vegetation due to disturbance (examples: fire or clear-cuts). However, when identifying the wetland type, an assessor will need to determine whether the full range of stable, existing wetland characteristics better resemble Non-Tidal Freshwater Marsh or another wetland type that existed prior to disturbance. Freshwater marshes found outside of floodplains or linear conveyances or in association with small (less than 20 acres) waterbodies are considered Small-Basin Wetlands. Localized depressions dominated by woody vegetation located within floodplains or adjacent to linear conveyances are considered Floodplain Pools.

Non-Tidal Freshwater Marsh includes NCNHP types Piedmont/Mountain Semi-permanent Impoundment (part), Coastal Plain Semi-permanent Impoundment (part), Natural Lake Shoreline (part). This type is included in the NCDCM wetland type of Freshwater Marsh. Non-Tidal Freshwater Marsh corresponds to HGM classes Riverine (sub-classes Headwater Complex, Beaver Impounded, and Human Impounded) and Lacustrine Fringe (sub-classes Semipermanently Flooded and Reservoir).

3.1.13-3

3.1.13-4

These examples of Non-Tidal Freshwater Marsh are located within a Riverine Swamp Forest in the Haw River floodplain, Guilford County (3.1.13-3) and along an intensively managed power line corridor over an unnamed tributary to the Cape Fear River, New Hanover County (3.1.13-4).


3.1.13-5

Photo 3.1.13-5 is an example of a Non-Tidal Freshwater Marsh in an intensively managed portion of the floodplain to Ragsdale Creek, Buncombe County. This wetland is the result of ground surface compaction and vegetation maintenance.

### 3.1.14 Tidal Freshwater Marsh

3.1.14-1

3.1.14-2

These examples of Tidal Freshwater Marsh are adjacent to Lockwood Folly River, Brunswick County (3.1.14-1); Sturgeon Creek, Brunswick County (3.1.14-2); an unnamed tributary to Hidden Lake in Palmetto-Peartree Preserve, Tyrrell County (3.1.14-3); and the Broad Creek Arm of South Lake in Alligator River National Wildlife Refuge, Dare County (3.1.14-4).

3.1.14-3

3.1.14-4

Tidal Freshwater Marshes are found in the tidewater portion of the Middle Atlantic Coastal Plain ecoregion on the margins of estuaries and in lower reaches of streams and rivers where they are saturated most of the time and are also subject to regular or occasional flooding by tides, including wind tides (regardless of whether or not the tidal waters reach the marshland areas through natural or artificial watercourses). Tidal Freshwater Marshes typically have salinities below the threshold of 0.5 parts per thousand (ppt), but may be subject to salinities above this threshold as a result of storm events. Tidal Freshwater Marshes occur on mineral or organic

soils. This wetland type is characterized by predominantly herbaceous vegetation (less than 50 percent coverage by living woody species). Tidal Freshwater Marshes typically support a larger diversity of plant species than either Non-Tidal Freshwater Marshes or Salt/Brackish Marshes. Indicators of degradation within this wetland type may include dead vegetation, ditching, spoil piles, reduced size, lack of vegetation diversity, presence of invasive species and saltwater intrusion. Presence of snags is only considered to be an indicator of degradation if there is evidence of a recent die-off.

Reference wetlands (see Section 3.2) are available for this type. These wetlands vary in size from small, narrow, fringing bands to broad patches extending hundreds of acres. Tidal Freshwater Marshes can transition upstream to Riverine Swamp Forest, upslope to Estuarine Woody Wetland, Non-Riverine Swamp Forest, and Pocosin, and downstream to Salt/Brackish Marsh.

Tidal Freshwater Marsh includes the NCNHP type Tidal Freshwater Marsh. This type is included in the NCDCM wetland type of Freshwater Marsh. Tidal Freshwater Marsh corresponds to the HGM class Estuarine Tidal Fringe (sub-classes Estuarine Lunar and Estuarine Wind).

### 3.1.15 Salt/Brackish Marsh

3.1.15-1


3.1.15-2

These examples of Salt Marsh are located along the lower Cape Fear River, New Hanover County (3.1.15-1); along an armored shoreline of Calico Creek, Carteret County (3.1.15-2); near Mad Inlet, Brunswick County (3.1.15-3); and along Bald Head Creek as viewed from the Bald Head lighthouse, Brunswick County (3.1.15-4).

3.1.15-3

3.1.15-4

Salt/Brackish Marshes are found in the tidewater region of the Middle Atlantic Coastal Plain ecoregion in areas subject to regular or occasional flooding by tides, including wind tides (whether or not the tidal waters reach the marshland areas through natural or artificial watercourses), provided that 1) water salinities equal or exceed 0.5 ppt during the period of average, annual low flow; 2) flooding by saline waters is not limited to storm events; and 3) woody vegetation constitutes less than 50 percent coverage of the community. The salt marsh component is associated more closely with ocean and inlet waters, while the brackish marsh component is somewhat removed from a direct connection with ocean and inlet saline waters. Salt/Brackish Marshes typically occur on both organic and mineral soils. This wetland type is

characterized by predominantly herbaceous vegetation (less than 50 percent coverage by woody species). Salt Marsh vegetation is dominated by saltmarsh cordgrass (*Spartina alterniflora*) and contains black needle rush (*Juncus roemerianus*), large saltmeadow cordgrass (*Spartina patens*), and sawgrass (*Cladium jamaicense*). Brackish marshes are typically more diverse in the vegetation assemblage and may include black needle rush, large saltmeadow cordgrass, giant cordgrass (*Spartina cynosuroides*), and sawgrass (Schafale and Weakley 1990).

Most examples of Salt/Brackish Marsh are considered by regulatory agencies as high quality wetlands. Indicators of degradation within this wetland type may include stands of dead vegetation, altered hydrology, ditching, spoil piles, reduced size, and extensive presence of invasive species.

3.1.15-5

3.1.15-6

These Brackish Marshes are in association with Estuarine Woody Wetland in Huddy Gut, Beaufort County (3.1.15-5); along Rose Bay at Bell Island, Swanquarter National Wildlife Refuge, Hyde County (3.1.15-6); adjacent to the battleship U.S.S. North Carolina, New Hanover County (supporting a stand of the exotic species *Phragmites australis*) (3.1.15-7); and adjacent to a roadside canal near the US 64/US 264 junction, Dare County (3.1.15-8).

3.1.15-7

3.1.15-8

Reference wetlands (Section 3.2) are available for this type. This wetland type may vary in size from small, narrow, fringing bands to hundreds of acres. Salt/Brackish Marsh can transition upstream to Tidal Freshwater Marsh, upslope to Estuarine Woody Wetland, Non-Riverine Swamp Forest, and Pocosin, and downstream to Salt/Brackish Marsh.

Salt/Brackish Marsh includes NCNHP types Salt Marsh, Brackish Marsh, and Salt Flat when these sites are wetlands. This type is included in the NCDCM wetland type of Salt/Brackish Marsh. Salt/Brackish Marsh corresponds with HGM class Estuarine Tidal Fringe (sub-classes Estuarine Lunar and Estuarine Wind).

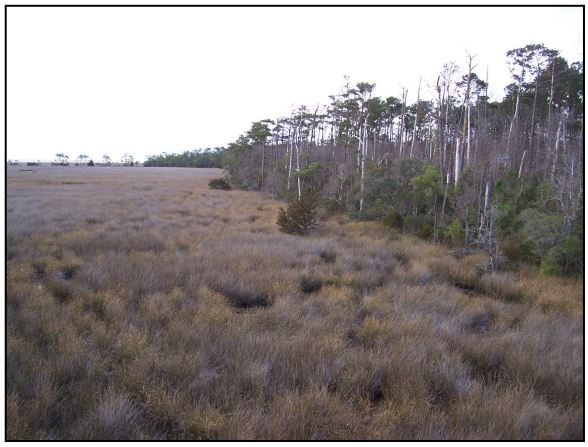
### 3.1.16 Estuarine Woody Wetland

3.1.16-1

3.1.16-2

These examples of Estuarine Woody Wetland are near the community of Mashoes, Dare County (3.1.16-1); on Bell Island near Rose Bay, Swanquarter National Wildlife Refuge, Hyde County (3.1.16-2); islands in a sea of brackish marsh along the Croatan Sound, Dare County (3.1.16-3); and a border along the upslope edge of brackish marsh along the Croatan Sound near Manns Harbor, Dare County (3.1.16-4).

3.1.16-3



3.1.16-4

Estuarine Woody Wetlands occur in the tidewater region of the Middle Atlantic Coastal Plain ecoregion. These wetlands are transitional in nature. They occur on the margins of estuaries, are associated with tidal marshes, and have the following attributes: 1) they are subject to occasional flooding from salt or brackish water; 2) they are subject to occasional flooding by tides, including wind tides (regardless of whether or not the tidal waters reach the marshland areas through natural or artificial watercourses); and 3) they are dominated (greater than 50 percent coverage) by woody vegetation including shrubs and trees. Estuarine Woody Wetlands occur on mineral or organic soils. Due to typically unstable hydrological and chemical

influences, the plant community is one adapted to disturbance, resulting in variable vegetation composition and physical structure. The vegetation assemblage is typically dominated by loblolly pine, cedars (*Juniperus* spp.) and hardwoods adapted to disturbance such as red maple and sweetgum, or by shrubs. Shrubs include bays, silverling (*Baccharis halimifolia*), marsh elder (*Iva frutescens*), and common wax myrtle (*Morella cerifera*). Herbs may include grasses and sedges from adjacent marshes.

Reference wetlands (Section 3.2) exist for this type; however, an assessor must recognize that this community occurs with variable vegetation composition and structure components. The size and shape of this wetland type is dependent on topography and disturbance (fire, clear-cutting, storm damage), and may range from narrow, sometimes intermittent bands along the outer fringe of Salt/Brackish Marshes to broad expanses of hundreds of acres. Estuarine Woody Wetland may transition up slope to Pocosin, Pine Flat, Hardwood Flat, and Non-Riverine Swamp Forest and down slope to Tidal Freshwater Marsh or Salt/Brackish Marsh.
Estuarine Woody Wetland includes NCNHP types Salt Shrub, Estuarine Fringe Loblolly Pine Forest, and Tidal Red Cedar Forest. This type is included in the NCDCM wetland type of Estuarine Shrub-Scrub and Estuarine Forested Wetlands. Estuarine Woody Wetland corresponds to HGM class Estuarine Tidal Fringe (sub-classes Estuarine Lunar and Estuarine Wind).

## 3.2 Wetlands and Reference

An understanding of the concept of a reference wetland is crucial for the appropriate use of NC WAM. A reference wetland (or wetland in reference condition) is a discrete wetland identified as a typical, representative, or common example of that particular wetland type without or removed in time from substantial human disturbance.

For the purpose of NC WAM, the term "reference wetland" includes a range of biotic and abiotic characteristics within each recognized wetland type and is synonymous with "relatively undisturbed." A reference wetland indicates quality along with the presence of expected functions for each general wetland type. An appropriate reference wetland needs to be comparable to the wetland being assessed, sometimes at a finer scale of resolution than the general wetland type. The reference wetland can thus serve to indicate what Hydrology, Water Quality, and Habitat functions the wetland under evaluation would have if it were unaltered.

### 3.2.1 Wetlands with Reference

NC WAM considers reference wetlands to be available for all general wetland types with the exception of Pine Flat, Non-Tidal Freshwater Marsh, and some sub-types of Small-Basin Wetland (see Section 3.1 for descriptions). Sub-types of Small-Basin Wetland that are considered to have reference include mafic depressions and Carolina bays.

In order to properly utilize NC WAM, assessors will need to be familiar with the physiography, hydrologic regime, water quality function, typical vegetation structure and composition, and wildlife attributes for the range of reference examples in each general wetland type. Currently, the best source of information concerning the location of reference wetlands is NCNHP mapping, which documents the locations of natural communities of North Carolina. Communities documented on this map base have been identified according to Classification of the Natural Communities of North Carolina: Third Approximation (Schafale and Weakly 1990). These NCNHP wetland community designations are cross-referenced with NC WAM wetland types in the NC WAM community descriptions (Section 3.1) and the wetland type cross-reference provided in Appendix B. A Geographic Information System (GIS) database (the NC WAM "tool box," see Section 5.1 and Appendix G) is currently under development for the purpose of providing on-site information about wetlands evaluated with the use of NC WAM. One of the resources intended to be available with this product will be the location and identification of wetlands considered to be in reference condition. Additional information provided for each reference wetland contained within the NC WAM "tool box" will include associated site mapping (aerial photography, topographic mapping, soils mapping), completed Field Assessment Form, Wetland Rating Sheet, and on-site photographs.

Because some of the general wetland types are heterogeneous in certain characteristics, it may be necessary to choose a site-specific reference – one that matches the site under evaluation more precisely than merely belonging to the same general wetland type. One example is

Bottomland Hardwood Forest. Reference wetlands for Bottomland Hardwood Forest might be quite different among ecoregions. For example, overbank flooding is often less influential for Bottomland Hardwood Forests west of the Middle Atlantic Coastal Plain ecoregion. Bottomland Hardwood Forests along brownwater streams receive more sediment and nutrients from overbank flooding than examples of this wetland type found along blackwater streams. Another example is Pocosin. The Pocosin general wetland type ranges widely in characteristics: from woodlands with substantial tree canopy on mucky mineral soils to nearly treeless shrub lands on deep peats. The appropriate site-specific reference for a Pocosin with mucky mineral soil is a relatively undisturbed Pocosin with mucky mineral soil, rather than one with deep peat. Absence of trees in the case of a Pocosin with mucky, deep, peat soil would not be considered a departure from reference.

For a few rare types, condition may need to be judged on its own merits against a conceptual reference condition synthesized from multiple altered remnants of the appropriate wetland type and literature review (examples: Pine Savanna and Seep). An important environmental factor for the maintenance of Pine Savanna is fire. Some Pine Savannas currently exist in areas subject to management with controlled burns, which maintains these wetlands in reference condition. Others exist in relatively undisturbed areas where fire is suppressed, resulting in a wetland type shift toward Pine Flat or Pocosin. The assessor will need to consider the true reference condition, characterized by regular fire events, when evaluating this wetland type. Seeps usually occupy small areas and can therefore be degraded by relatively local activities. Again, an assessor will need to consider the reference condition of an undisturbed seep in the appropriate landscape when evaluating this wetland type.

### 3.2.2 Wetlands without Reference

Some wetlands will not have a usable reference. Pine Flat, Non-Tidal Freshwater Marsh, and some sub-types of Small-Basin Wetland (for instance, freshwater marshes in man-made ponds) consist largely of successional wetlands for which a natural reference condition is not distinguishable. For instance, stable lime sink depressions may be characterized by vegetation that ranges in structure from a well-stratified forest, to coverage by woody and herbaceous vegetation, to domination by wetland or emergent herbs, to domination by aquatic emergents or submergents. The same metrics are used by NC WAM to generate functional ratings for both wetlands with reference and wetlands without reference, so it is important that the assessor be knowledgeable concerning whether each general wetland type assessed can be evaluated relative to reference condition or not.

## 3.3 Intensively Managed Wetlands

Although not a true general wetland type, wetlands which are “intensively managed” include any wetland that has been severely altered or unintentionally created by humans and is maintained in a severely altered state. Intensively managed wetlands have degraded wetland functions, but the sites remain jurisdictional wetlands. These areas may include, but are not limited to, farmed wetlands and mowed wetlands within utility line corridors. Intensively managed wetlands

correspond to the NCDCM wetland types of Managed Pinelands, Human Impacted Wetlands, and Cleared Wetlands – if still jurisdictional. If an assessor determines that a specific wetland is intensively managed, NC WAM requires that the assessor document this fact on the Field Assessment Form, then proceed to classify the wetland as the original, naturally occurring type if this determination can be made. If the current, full range of stable, existing wetland characteristics (vegetation, soils, and hydrology) better resemble another wetland type because of long-established, permanent alterations, the wetland should be classified and evaluated as this current, more appropriate type. In this case, a naturally occurring example of the closest wetland type should be used as a reference, if appropriate.

### 3.4 Key to General Wetland Types

The initial step in the field application of NC WAM is to clearly identify the various wetland types found at the site to be evaluated. To this end, NC WAM uses a dichotomous key to general North Carolina wetland types (see NC WAM forms provided at the beginning of the User Manual [current version 5.13, October 9, 2006]) to assist assessors with identification. Assessors will need to be familiar with characteristics of the general wetland types in order to properly utilize the key.

Within the dichotomous key text, an underlined "and" (and) indicates that two or more conditions must be met to continue on a particular branch of the key. An underlined "or" (or) indicates that any one of multiple conditions can be met to continue on a particular branch of the key.

It is important that the assessor walk the entire wetland area prior to making a determination as to the wetland type(s) present. If the assessor believes a wetland can reasonably fit into more than one wetland type, the wetland can be rated as each potential wetland type. The assessor may then use best professional judgment to determine the appropriate rating for the assessment area. The assessor should always document the decision-making process.

Following is a discussion of decision making points used in the dichotomous key to general wetland types.

I. Wetland affected by lunar or wind tide, may include woody areas adjacent to tidal marsh
II. Wetland not affected by tides

The first decision separates wetlands in terms of tidal versus non-tidal influence. The question of tidal influence is exclusive of salinity. The term "tidal" typically refers to a situation in which the water level periodically fluctuates due to the action of lunar and solar forces upon the rotating earth (Environmental Laboratory 1987). "Wind tides" refer to water table fluctuations due to the action of wind on the water surface. For the purpose of NC WAM, lakes or waterbodies greater in size than 20 acres (examples: Lake Phelps, Lake Waccamaw, Lake

Mattamuskeet) may have sufficient fetch to be considered subject to wind tides. However, this characteristic may be more likely to occur on lakes in the Coastal Plain ecoregions, which are characterized by extensive shallows along the rims, as opposed to lakes in the Piedmont and Blue Ridge Mountains ecoregions, which are characterized by greater depths and steeper slopes along the rims. A wetland is considered to be subject to tides even when tidal waters reach the wetland through an artificial watercourse (such as a ditch, canal, or pipe through a berm).

I.A. Wetland affected, at least occasionally, by brackish or salt water
  I.A.i. Dominated by herbaceous vegetation – **Salt/Brackish Marsh**
  I.A.ii. Dominated by woody vegetation – **Estuarine Woody Wetland**
I.B. Wetland primarily affected by freshwater
  I.B.i. Dominated by herbaceous vegetation – **Tidal Freshwater Marsh**
  I.B.ii Dominated by woody vegetation – **Riverine Swamp Forest**

This decision requests the assessor to determine whether or not a wetland is subject to saline waters at least occasionally. NC WAM considers brackish, estuarine, and salt water to be included in this category, which is defined by waters in which ocean-derived salts measure 0.5 parts per thousand or greater. In regards to Estuarine Woody Wetlands, "affected at least occasionally" may include being affected by saline waters due to aperiodic events such as storms (tropical cyclones, northeasters). The frequency of such aperiodic events must be sufficient for salinity to have an observable effect on community biology. Both Riverine Swamp Forest and Tidal Freshwater Marsh are considered to be affected by saline waters so infrequently that salinity has little to no effect on community biology. No map source has been established for this determination, so, in the absence of water chemistry data, the assessor will need to rely on site-specific evidence (such as plant species present) and best professional judgment. Some plant species common to this landscape position are intolerant of salt water (such as pond pine [*Pinus serotina*], bald cypress [*Taxodium distichum*], and gallberry [*Ilex glabra* and *I. coriacea*]) and may provide useful indicators in making this determination.

The phrase "dominated by" refers to a biological, chemical, or physical feature that exerts a controlling influence on or defines the character of a community. For the purpose of NC WAM, vegetation dominance is considered in terms of areal coverage (or "drip line" coverage) rather than number of stems. A wetland dominated by herbaceous vegetation is characterized by greater than 50 percent coverage of herbs and less than 50 percent coverage by woody plants. A wetland dominated by woody vegetation is characterized by greater than 50 percent coverage of woody vegetation, regardless of the percent coverage of herbs.

4.4-1

4.4-2

Photo 4.4-1 is a wetland along the shoreline of Croatan Sound in Dare County. This wetland is affected, at least occasionally, by brackish or salt water, is dominated by herbaceous vegetation, and therefore keys out as a Salt/Brackish Marsh. Photo 4.4-2 is a wetland along the shore of East Lake in Dare County. This wetland is affected, at least occasionally, by brackish or salt water, is dominated by woody vegetation, and therefore keys out as an Estuarine Woody Wetland. Photo 4.4-3 is a wetland along the bank of Town Creek in Brunswick County, and Photo 4.4-4 is a wetland along the bank of Lockwood Folly River in Brunswick County. Both wetlands support species with little to no salt tolerance suggesting they are primarily affected by freshwater. The Town Creek wetland is dominated by woody vegetation and keys out as a Riverine Swamp Forest, while the Lockwood Folly River wetland is dominated by herbaceous vegetation and keys out as a Tidal Freshwater Marsh.

4.4-3

4.4-4

II.A. Not in a geomorphic floodplain and not associated with a natural linear conveyance (such as a topographic crenulation), nor associated with a natural lake greater than or equal to 20 acres in size

II.B. In a geomorphic floodplain or associated with a natural linear conveyance (such as a topographic crenulation) or along shorelines of natural water bodies greater than 20 acres or artificial impoundments

This decision requires the assessor to determine whether or not the wetland is affected by riverine hydrology or more directly drains into/influences a riverine system. The term "geomorphic" is intentionally used to avoid the need for the assessor to make a determination as to whether or not the floodplain is active. NC WAM does not require that there be any sign of overbank flow for a wetland to be considered a riverine system, only that the wetland be located in a geomorphic floodplain.

An assessor may have a difficult time determining if a specific site is in a geomorphic floodplain when in the embayed region of North Carolina. In the embayed region, some interstream flat wetlands may occur within geomorphic floodplains. In some cases, the assessor may use the county soil survey descriptions to determine if the assessment area is expected to be subject to riverine hydrology. In the absence of such information, the assessor should rely on best professional judgment in this decision.

For many floodplains, especially west of the Mid-Atlantic Coastal Plain ecoregion, overbank flooding may not be an important source of wetland hydrology. "Natural linear conveyance" includes small streams without a floodplain and linear wetlands, and excludes man-made features (ditches, canals). A crenulation is a linear, topographic feature that is less well developed than a stream channel or valley and is characterized by "v"-shaped contour lines on topographic mapping. Crenulations are typically smaller-scale, localized features as opposed to larger-scale, landscape-wide features. Large natural lakes (greater than 20 acres) are considered to impart riverine characteristics (in terms of hydrology) on adjacent wetlands due to seasonal fluctuations in water level and the potential for periodic wind tides. The size threshold has been taken from Cowardin et al. (1979). Wetlands included in II.A. may occur on interstream flats or divides, coastal islands, side slopes, ridges, saddles, and depressions, regardless of the presence of man-made conveyances (ditches, canals).

II.A.i. On side slopes – **Seep**

II.A.ii. On interstream divides or on a coastal island

This decision separates Seep from wetland types located outside of a geomorphic floodplain and not associated with a linear conveyance. Seeps typically occupy small areas located throughout the state outside of geomorphic floodplains on sloping hillsides and not on flats. In many cases, the location of a seep may be determined by an impermeable layer (such as subsurface rock or a clay lens) that directs groundwater to the surface. Though not immediately

associated with a linear conveyance, surface water from a Seep may drain to a zero- or first-order stream or riverine wetlands (Headwater Wetland, Bottomland Hardwood Forest, Riverine Swamp Forest, and Floodplain Pool). Most North Carolina coastal islands are not large enough or characterized by sufficient topography to develop geomorphic floodplains.

II.A.ii.1. Flats on interstream divides in Coastal Plain ecoregions
II.A.ii.2. In depressions surrounded by uplands anywhere in the state (mafic depressions, lime sinks, Carolina bays) or on shorelines of lakes/ponds

This decision separates expansive wetlands typical of relatively flat interstream divides (Hardwood Flat, Pine Flat, Pine Savanna, and some sub-types of Pocosin) from smaller, localized wetlands typically found in topographic depressions (Small-basin Wetland and some sub-types of Pocosin – see wetland sub-types listed in the question). A depression may be located within an interstream divide landscape position, but the key separates depressions from interstream flat wetlands by the characteristic local topography.

II.A.ii.1.a. Dominated by deciduous trees
- II.A.ii.1.a.i. Intermittently to seasonally inundated (typically dominated by sweetgum and oaks) – **Hardwood Flat**
- II.A.ii.1.a.ii. Seasonally to semi-permanently inundated (typically dominated by cypress and black gum) – **Non-Riverine Swamp Forest**

II.A.ii.1.b. Dominated by evergreens
- II.A.ii.1.b.i. Dominated by dense, waxy shrub species (typically include gallberries, fetterbushes, honeycup, greenbriar; canopy may include pond pine, Atlantic white cedar, and bays) – **Pocosin**
- II.A.ii.1.b.ii. Not dominated by dense, waxy shrub species
  - II.A.ii.1.b.ii.1. Dominated by long-leaf or pond pine and wire grass – **Pine Savanna**
  - II.A.ii.1.b.ii.2. Dominated by loblolly or slash pines – **Pine Flat**

The phrase “dominated by” refers to a biological, chemical, or physical feature that exerts a controlling influence on or defines the character of a community. For the purpose of NC WAM, vegetation dominance is considered in terms of areal coverage (or “drip line” coverage) rather than number of stems. In order to determine dominance between deciduous and evergreen trees or types of shrub species, the assessor may choose to employ the “50/20 rule.” This is the recommended method for selecting dominant species from a plant community when quantitative data are available. The most abundant species (when ranked in descending order of abundance and cumulatively totaled) that immediately exceed 50 percent of the total dominance measure for a given stratum, plus any additional species comprising 20 percent or more of the total dominance measure for that stratum, are considered dominant species for the stratum (USFWS et al. 1989). Wetland hydrology terms are derived from Cowardin et al.

(1979). See general wetland type descriptions (Section 3.1) for more detailed characteristics used to separate these wetland types.

II.A.ii.2.a. Dominated by dense, waxy shrub species (typically include gallberries, fetterbushes, honeycup, greenbriar); canopy may include pond pine, Atlantic white cedar, and bays and not characterized by clay-based soils – **Pocosin**

II.A.ii.2.b. Not dominated by dense, waxy shrub species and not characterized by a peat-filled bay – **Small-Basin Wetland**

This decision effectively separates two general wetland types which both have many possible forms. This form of Pocosin includes Carolina bay wetlands, which may vary in form from tall, vertically stratified pond pine woodlands, to tall, less well stratified high pocosin, to a short pocosin with little stratification. Carolina bay wetlands may or may not have an associated body of open water. Small-Basin Wetlands include lime sink ponds, mafic depressions, ephemeral pools, man-made ponds in interstream flats, fringing wetlands on shorelines of lakes or ponds 20 acres or less in size.

II.B.i. Northern Inner Piedmont or Blue Ridge Mountains ecoregions and dense herbaceous or mixed shrub/herbaceous vegetation with characteristic bog species (see wetland type description), with or without tree canopy; typically long-duration saturation; sphagnum moss commonly present – **Mountain Bog**

II.B.ii. Anywhere in the state and not Mountain Bog

This decision separates Mountain Bog from all other riverine wetland types. See the general wetland type description (Section 3.1.11) for more detailed characteristics used to identify the Mountain Bog wetland type.

II.B.ii.1. Dominated by herbaceous vegetation. At least semi-permanently inundated or saturated. Includes lacustrine and riverine fringe, and beaver ponds with dense herbaceous vegetation of large, grass-like plants and forbs, sphagnum moss scarce or absent – **Non-tidal Freshwater Marsh**

II.B.ii.2. Dominated by woody vegetation. Trees may be present on edges or hummocks

Dominance by plant type is concerned with “living” vegetation in the air space over the wetland (though the plants may be rooted outside of the wetland type) as well as vegetation growing within the wetland. A small Floodplain Pool may not support woody vegetation within its boundaries, but may still be dominated by woody vegetation from the adjacent floodplain forest. If the site is a riverine forested community that has been affected by beaver impoundment, the assessor needs to decide if the full range of stable, existing wetland characteristics (vegetation, hydrology, and soils) better resemble a marsh or a forested wetland. If the assessor is in doubt as to the keyed wetland type, the site should be rated as each likely wetland type.

II.B.ii.2.a. Localized depression; semi-permanently inundated – **Floodplain Pool**
II.B.ii.2.b Not a localized depression

A localized depression may not have a regular surface wetland or stream connection to another wetland type. Examples of this are oxbows, backwaters along the toe of floodplain slopes, and tree tip depressions. Localized depressions directly connected to adjacent wetlands (possibly Bottomland Hardwood Forest or Riverine Swamp Forest) would often be considered a component of the adjacent wetland type.

II.B.ii.2.b.i. Zero- to 1st-order stream. May be 2nd- or 3rd-order stream in Sandhills level IV ecoregion. Diffuse surface flow and groundwater more important than overbank flooding.
- II.B.ii.2.b.i.1 Intermittently inundated to seasonally saturated – **Headwater Wetland**
- II.B.ii.2.b.i.2. Seasonally to semi-permanently inundated – **Riverine Swamp Forest**

I.B.ii.2.b.ii. Second-order or greater stream or associated with the shoreline of waterbodies 20 acres or greater
- I.B.ii.2.b.ii.1. Intermittently to seasonally inundated for long duration (may be dominated by sweetgum, ash, sycamore, and oaks) – **Bottomland Hardwood Forest**
- I.B.ii.2.b.ii.2. Seasonally to semi-permanently inundated for very long duration (may be dominated by cypress and gums in Coastal Plain and ash, overcup oak, and elms in Piedmont and Mountains) – **Riverine Swamp Forest**

In much of the state, stream order may be determined by consulting blue lines on the most recent version of the 1:24,000 USGS topographic map; however, for sites in the Coastal Plain ecoregions, the assessor should not incorporate ditches in the determination of stream order. The assessor should use best professional judgment to decide when to defer to field observations over USGS mapping. Appendix C contains a schematic diagram to assist the assessor with understanding how to determine stream order. A soil survey may be helpful to an assessor if there is a question about whether or not an assessment area is in the floodplain of a second-order or greater stream. For instance, in the Piedmont, if a soil survey indicates that a floodplain is not underlain by Chewacla soils, then the assessment area is likely in a lower-order stream floodplain. Wetland hydrology terms are derived from Cowardin et al. (1979).

## 4.0 FUNCTIONAL ASSESSMENT METRICS

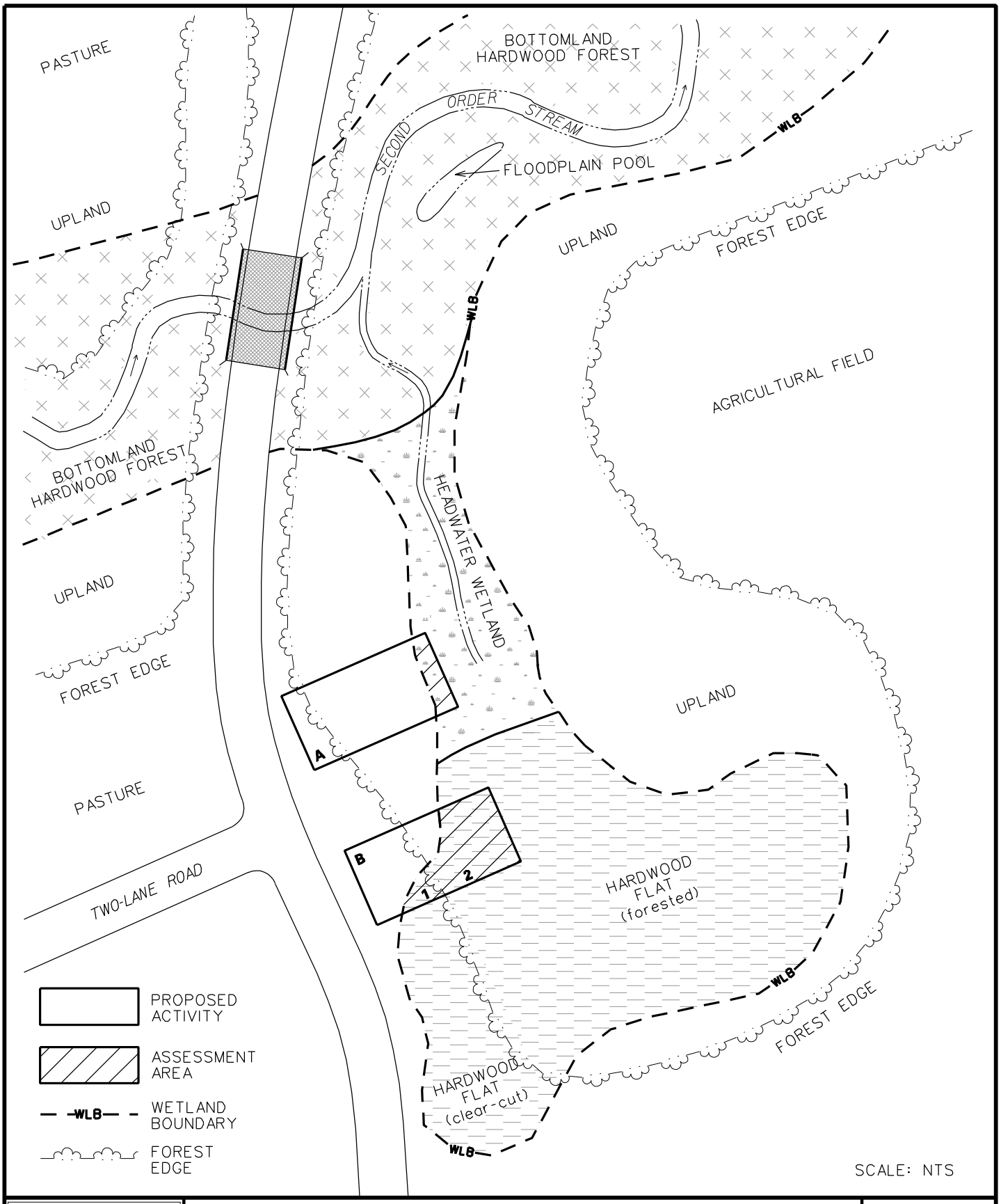
### 4.1 Introduction to Metrics

NC WAM uses assessment of wetland condition as an alternative to direct assessment of wetland function. Wetland condition can be observed, and is more readily assessed than wetland function, which must be measured or inferred. The method of determining the condition and opportunity of a specific wetland is to answer a series of questions or **metrics** concerning 1) the observable condition of the wetland and 2) the opportunity provided to the wetland for potential enhancement of wetland functions due to disturbance in the watershed draining to the wetland. A list of metrics specific to each general wetland type was generated by the WFAT. Metrics corresponding to wetland types with a reference standard are designed to assess the departure of wetland condition from the reference standard. All metrics for all wetland types were field tested and revised at multiple test sites representing various levels of disturbance, from relatively pristine to intensively managed. Following initial field testing, state and federal agency personnel participated in beta-testing exercises across the state concerning the applicability of metrics for all general wetland types. Beta testing included a classroom explanation of the method, field exercises, and a provision for comments by beta testers regarding the draft method. Following beta testing, metrics for each of the general wetland types were finalized. The NC WAM Technical Document ("N.C. Wetland Assessment Method [NC WAM] Technical Document," expected completion early 2007) provides the comprehensive list of these metrics.

The comprehensive metric list for all general wetland types includes 63 individual metrics. For the purpose of generating a single, relatively concise field metric evaluation form, the original 63 metrics were separated into component parts, reorganized, and condensed into the 22 "condensed" metrics (hereafter referred to as metrics) now presented on the Field Assessment Form (see NC WAM forms provided at the beginning of the User Manual [current version 3.13, January 12, 2007]). On the Field Assessment Form, each metric is presented in the form of a multiple-choice question. The selected answers, or "**descriptors**," are then used by the NC WAM rating calculator (computer program) to determine wetland functional ratings.

### 4.2 Metric Evaluation Areas

Each metric requests the assessor to evaluate field indicators within one or more specific areas. The title line for each metric on the Field Assessment Form indicates the area(s) of consideration for that metric. Four different areas may be considered: 1) an area limited to the "assessment area", 2) the "wetland type" as a whole (whether or not included in the assessment area), 3) the "wetland complex" (all wetland types contiguous with the assessment area), and 4) the natural "landscape patch" (all contiguous habitat [wetland and non-wetland] that includes the assessed wetland type). Figure 3 is referred to for illustrations of these areas in the following discussion.




NC WAM USER MANUAL

# EXAMPLE WETLAND COMPLEX

MAY 2007

FIGURE

3

The **assessment area** is the defined area of wetland subjected to the functional evaluation. The boundary of the assessment area may be determined by the boundary of a proposed activity, confined to a single wetland type within the footprint of a proposed activity, or confined to the extent of a wetland type with a homogeneous set of characteristics within the footprint of a proposed activity.

In Figure 3, the footprint of the proposed activity labeled "A" includes a Headwater Wetland. The portion of this Headwater Wetland that falls inside the boundaries of proposed activity A is an NC WAM assessment area (see hatched area). The footprint of the proposed activity labeled "B" includes a Hardwood Flat, a portion of which has been subject to clear-cutting. If wetland characteristics are substantially different between these two versions of the Hardwood Flat, they will be considered separate sub-types, and an assessor will need to conduct a functional evaluation on two assessment areas: assessment area B1 and assessment area B2 in Figure 3.

"Assessment area" metrics focus only on the field indicators evident in the assessment area. The characteristics of any portion of wetland outside of the assessment area should not be considered when evaluating assessment area metrics.

The **wetland type** is a continuous wetland area comprised of one of the 16 general wetland types defined for use by NC WAM. The boundary of a wetland type may consist of a wetland/upland boundary or another wetland type boundary. A wetland type determination may be made based on general wetland type descriptions (see Section 3.1), with the use of the NC WAM Dichotomous Key to General NC Wetland Types (see NC WAM forms provided at the beginning of the User Manual [current version 5.13, October 9, 2006]), or following guidelines provided for the identification of unique or problematic wetland types (see Section 5.2.2.2).

"Wetland type" metrics require the evaluation of field indicators evident throughout the entire wetland type. If wetland characteristics vary within the wetland type, the assessor will evaluate metrics based on the dominant field indicators. Using the example in Figure 3, a wetland type metric used in the functional evaluation of assessment area A will need to consider dominant field indicators of the entire Headwater Wetland, not just the portion within the assessment area.

The **wetland complex** is an association of two or more NC WAM general wetland types that are contiguous and hydrologically connected. "Wetland complex" metrics typically provide a list of landscape features that may form boundaries (examples: uplands, four-lane roads, urban landscapes, open water exceeding a specific width). Regarding the example provided in Figure 3, all three wetland types displayed (Bottomland Hardwood Forest, Headwater Wetland, and Hardwood Flat) are contiguous and hydrologically connected, and are therefore considered to be part of a single wetland complex.

"Wetland complex" metrics typically ask broad questions (such as general sizes and widths) and are not expected to require detailed information concerning function field indicators. These data are best determined from the examination of maps, which may be accomplished most efficiently in the office.

The **landscape patch** is the contiguous natural habitat that includes the assessment area irrespective of the watershed of the assessment area. "Landscape patch" is used in only one metric (Field Assessment Form metric number 13; see NC WAM forms provided at the beginning of the User Manual [current version 3.13, January 12. 2007]), which concerns the area of available habitat associated with the assessment area. This metric defines landscape patch boundaries as created by four-lane roads, urban landscapes, pasture and agricultural fields, or open water greater than 300 feet wide. In the example given in Figure 3, all of the forested habitats are part of a contiguous landscape patch.

## 4.3 Guidance for Completing the Field Assessment Form

It is important that the assessor walk the entire assessment area prior to completing the Field Assessment Form. During this investigation, the assessor should make note of the presence of potential wetland stressors (such as roads, utility lines, maintained vegetation, septic fields, and stormwater runoff) and consider the effect of potential stressors on the subject wetland. The assessor should take notes liberally, documenting important site features and reasoning used in best professional judgment on the Field Assessment Form. A sketch map (or higher quality) indicating assessment area characteristics should be generated and attached to the completed Field Assessment Form.

### 4.3.1 Field Assessment Form Introductory Information

The most current version of the Field Assessment Form as of the date of the generation of this User Manual is version 3.13, dated January 12, 2007. This form is provided at the beginning of the User Manual. The box at the top of the first page requests general information concerning the setting, time, and assessor involved in the wetland assessment.

- Wetland Site Name – name used to identify the assessed wetland site
- Wetland Type – based on use of the general wetland type key or best professional judgment
- Level III Ecoregion – based on the ecoregion map provided in Appendix F
- River Basin – name of river basin
- Precipitation within 48 hours – indicate whether measurable rainfall has fallen within the past 48 hours (http://www.srh.noaa.gov/rfcshare/precip_analysis_new.php for assistance)
- Date – date of the field assessment
- Assessor Name/Organization – name and affiliation (agency, company) of the party responsible for the evaluation decisions

- Nearest Named Water Body – name of the nearest named water body as indicated on the latest USGS 7.5-minute topographic quadrangle or other reliable resource
- USGS 8-Digit Catalogue Unit – provide the 8-digit catalogue unit (available from USGS 1974 and NCDWQ basinwide management plans - http://h2o.enr.state.nc.us/basinwide)
- Latitude/Longitude (deci-degrees) – coordinates in six-digit decimal degrees

The section entitled "Evidence of stressors affecting the assessment area" is meant to prompt the assessor to consider the overall condition of the assessment area by looking for evidence of environmental stressors. Comments provided by the assessor will be for the use of resource agency personnel and are not directly involved in generating the assessment ratings. The term "consider departure from reference, if appropriate, in recent past" is intended to prompt the assessor to consider whether the vegetation appears to have been disturbed within approximately the past 10 years. The bulleted list provides examples of common disturbances which are generally considered to reduce wetland function. The assessor should record whether or not the assessed wetland is intensively managed.

The section entitled "Regulatory Considerations" simply requests that the assessor acknowledge, by selecting the corresponding box, known issues concerning the site which are regulated by one or more federal, state, or local natural resource agencies.

- Anadromous fish – The assessor should select "Anadromous fish" if there are either direct observations or documentation of presence of these species within a stream associated with the assessment area.
- Federally protected species or State endangered or threatened species – The assessor should select "Federally protected species," if there are either direct observations or documentation of presence of these species within the assessment area. Sources for documentation include the U.S. Fish and Wildlife Service and the N.C. Natural Heritage Program.
- NCDWQ riparian buffer rule in effect – The assessor should select "Riparian buffer rule in affect" only if the N.C. Environmental Management Commission (EMC) has instituted buffer rules that apply to the assessment area (located on the web at http://h2o.enr.state.nc.us/streams.html).
- Wetland adjacent to or associated stream drains to a Primary Nursery Area – Information concerning the identification and location of Primary Nursery Areas is available in 15A NCAC 03N 0.0104 and 15A NCAC 03R .0103, respectively.
- Publicly owned property– Property ownership should always be established prior to an assessor making a site visit.
- NCDCM Area of Environmental Concern (AEC) (including buffer) – Communication with a NCDCM representative or familiarity with the most current version of the "CAMA Handbook for Development in Coastal North Carolina" (located on the web at http://dcm2.enr.state.nc.us/) will aid the assessor in determining whether the assessment area includes an Area of Environmental Concern (AEC).

- NCDWQ best usage classification of SA or supplemental classifications of HQW, ORW, or Trout – Surface water quality classifications and definitions for terms such as High Quality Waters (HQW), Outstanding Resource Waters (ORW), and Trout Waters (Trout) are available through NCDWQ stream classification schedules and other publications (including http://h2o.enr.state.nc.us/bims/reports/reportsWB.html).
- Designated NCNHP reference community – Information concerning the location of NCNHP-designated reference communities is available through NCNHP publications such as county inventories and lists of Significant Natural Heritage Areas.

The type of natural stream is important information used by the rating calculator for riverine wetlands. Blackwater streams are Coastal Plains streams that contain negligible amounts to no sediment, are tannic in nature, and often flow through peat-based or sandy areas. Brownwater streams generally originate in the Piedmont or Blue Ridge Mountains ecoregions and often contain high amounts of clay and silt and are therefore often turbid and brown in color. The breakdown of source of tides is used to locate wetlands in the landscape. Acknowledging that a wetland occurs on a coastal island potentially prevents a lowering of wetland rating based on size when an assessment area is confined to an island. Acknowledgement that a wetland is affected by beaver provides additional information for consideration to assessment reviewers. Important terms are defined in the glossary (Appendix L).

### 4.3.2 Field Assessment Form Metrics

The metric name, metric scope, and metric type are included on the metric title line. Consider metric number 1 for example.

**1. Ground Surface Condition/Vegetation Condition – assessment area condition metric**

In this case, the assessor is to consider the assessment area when evaluating both the “ground surface condition” and “vegetation condition” components of this metric. This is a condition metric because the assessor uses it to evaluate the extent to which a wetland departs from full integrity with respect to these components.

Each metric is composed of one or more questions. For each metric, the assessor is provided two or more possible answers or “descriptors.” Each descriptor is accompanied by a box. The evaluation of each metric will involve the selection of one or more descriptors by checking the appropriate boxes.

Each of the 22 metrics included on the Field Assessment Form follows along with a clarifying discussion. The Field Assessment Form is included at the beginning of the User Manual (current version 3.13, January 12. 2007).

**1. Ground Surface Condition/Vegetation Condition – assessment area condition metric**

**Check a box in each column. Consider alteration to the ground surface (GS) in the assessment area and vegetation structure (VS) in the assessment area. Compare to reference wetland if applicable (see User Manual version 1.0). If a reference is not applicable, then rate the assessment area based on evidence of alteration.**

| GS | VS | |
|---|---|---|
| ☐A | ☐A | **Not severely altered** |
| ☐B | ☐B | **Severely altered over most of the assessment area (ground surface alteration examples: vehicle tracks, excessive sedimentation, fire-plow lanes, skidder tracks, bedding, fill, soil compaction, obvious pollutants) (vegetation structure alteration examples: mechanical disturbance, herbicides, salt intrusion [where appropriate], exotic species, grazing, less diversity [if appropriate], artificial hydrologic alteration)** |

With regard to ground surface, the assessor should consider the assessment area when evaluating this metric and should check one box in the GS column. The ground surface component addresses the departure from reference of the ground surface condition. The metric is applicable to the Habitat function in all general wetland types and the Water Quality function in Non-tidal Freshwater Marsh, Seep, and Mountain Bog. Departure from reference may include ground surface disturbances which would degrade egg-laying or feeding habitat for amphibians or fish or modifications reducing the retention time of surface water. The examples of disturbance provided, when found in sufficient severity and with coverage of over 50 percent of the assessment area, are anticipated to degrade ground surface habitats enough to receive a descriptor of "B." Evidence of local (not severe) disturbances such as small numbers of fire plow lanes or skidder trails, or shallow tire ruts are likely not sufficient evidence to receive a descriptor of "B." Evidence that an area has previously been ditched but now the ditches have been partially back-filled (naturally or intentionally) is sufficient to rate a "B."

With regard to vegetation structure, the assessor should consider the assessment area when evaluating this metric and check a box in the VS column. The vegetation structure component addresses the departure from reference of the vegetation structure. This metric is applicable to the Habitat function in all wetland types and the Water Quality function in Seep and Mountain Bog. The assessor should consider the following in terms of Habitat: are expected strata present, or has disturbance resulted in the elimination of one or more expected strata or the addition of one or more unexpected strata? In terms of Water Quality, the assessor should consider whether a disturbance has occurred which reduces the residence time for treatment of surface water. In this case, vegetation condition is considered a surrogate for disturbance. Examples of disturbance resulting in severe alteration of the vegetation structure include logging, die-off due to recent beaver impoundment or insect infestation, and storm damage. Vegetation removal may result in both an increase in surface storage capacity (due to surface roughening) and a reduction of water transport out of the wetland (evapotranspiration).

The recently clear-cut Bottomland Hardwood Forest depicted by photo 3.1.1-3 is characterized by a descriptor of "B" for both ground surface condition and vegetation condition. The beaver-impacted Headwater Wetland depicted by photo 3.1.3-4 and the intensively managed (regularly mowed) Pocosin depicted by photo 3.1.5-3 are characterized by a descriptor of "B" for vegetation condition.

**2. Surface and Sub-Surface Storage Capacity and Duration – assessment area condition metric**

**Check a box in each column. Consider surface storage capacity and duration (Surf) and sub-surface storage capacity and duration (Sub). Consider both increase and decrease in hydrology. Refer to the NRCS Scope and Effect Guide for North Carolina hydric soils (see User Manual v1.0 Appendix G) for the zone of influence of ditches in hydric soils. A ditch ≤ 1 foot deep is considered to affect surface water only, while a ditch > 1 foot deep is expected to affect both surface and sub-surface water. Consider tidal flooding regime, if applicable.**

| Surf | Sub | |
|---|---|---|
| ☐A | ☐A | **Water storage capacity and duration are not altered.** |
| ☐B | ☐B | **Water storage capacity or duration are altered, but not substantially (typically, not sufficient to change vegetation).** |
| ☐C | ☐C | **Water storage capacity or duration are substantially altered (typically, alteration sufficient to result in vegetation change) (examples: intensive ditching, fill, sedimentation, channelization, diversion, man-made berms, beaver dams, stream incision, sewer lines, soil compaction).** |

This metric is a key to an accurate assessment because it is used in the evaluation of all three wetland functions. The assessor should consider the assessment area when evaluating this metric and should check one box in each column.

The surface storage capacity and duration component (Surf) is concerned with the departure from reference with respect to all three wetland functions in most general wetland types (the exception is Bottomland Hardwood Forest, where this metric is only used for the Habitat function). The assessor is asked to determine among the possibilities of no alteration, little alteration, or substantial alteration. The assessor should be able to determine visually if the ground surface has been disturbed enough to remove "A" as a possibility. The condition and/or species composition of vegetation should be used to determine between a "B" and a "C." In order for ditches to be considered effective, they must be connected to a stream system, pond, or other receiving water. If ditches are not connected to a receiving water, they will not provide drainage but may provide surface storage. In cases of effective artificial drainage through ditching of a wetland, the assessor may use the North Carolina Scope and Affect Guide (Appendix G) to determine distance adjacent to a ditch for which wetland hydrology can be expected to be removed. This guide has been prepared by the Natural Resources Conservation Service (NRCS) and has been accepted for conditional use in estimating the status of wetland hydrology by the USACE. In the absence of other on-site information, this guide can be used to roughly estimate the effect of known ditching on wetland hydrology. A single ditch across an assessment area is typically not enough to downgrade an evaluation. A ditch on the fringe of a wetland effect should be evaluated no lower than a "B." For the purpose

of NC WAM, a ditch needs to exceed a foot in depth to be considered to degrade sub-surface wetland hydrology. The threshold of 1 foot for depth has been derived from the 1-foot threshold used by the USACE to determine presence of wetland hydrology (Environmental Laboratory 1987).

The sub-surface storage capacity and duration component (Sub) is concerned with the departure from reference with respect to the Hydrology and Water Quality functions. The assessor is again asked to determine among the possibilities of no alteration, little alteration, or substantial alteration. In areas supporting histic epipedons or histisols, ditching must extend below the surface peat and into the subsoil to be considered to have an effect on sub-surface hydrology. The assessor should also consider departure from reference of sub-surface hydrology resulting from impoundment (such as surface berms, construction of underground utility lines, and beaver dams). Clear-cutting of wetlands is known to compact surface soils, especially if the activity occurred in winter when soils are wetter. Such compaction reduces infiltration to the sub-surface and increases surface inundation.

**3. Water Storage/Surface Relief – assessment area/wetland type condition metric**

**Check a box in each column. Select the appropriate storage for the assessment area (AA) and the wetland type (WT).**

| AA | WT | |
|---|---|---|
| ☐A | ☐A | **> 50% of the wetland type with depressions able to pond water > 2 feet deep** |
| ☐B | ☐B | **> 50% of the wetland type with depressions able to pond water 1 to 2 feet deep** |
| ☐C | ☐C | **> 50%of wetland type with depressions able to pond water 6 inches to 1 foot deep** |
| ☐D | ☐D | **> 50% of wetland type with depressions able to pond water 3- to 6-inches deep** |
| ☐E | ☐E | **Depressions able to pond water < 3-inches deep** |

4.3.2.3-1

Photo 4.3.2.3-1 depicts a Pocosin characterized by greater than 50 percent of the wetland type with depressions able to pond water 1 to 2 feet deep (note the auger with a 3-foot shaft).

The assessor should consider the assessment area (AA) and then the wetland type (WT) separately when evaluating this metric. This metric addresses departure from reference in the amount of water that can be stored above ground surface with respect to the Hydrology function for selected wetland types. The assessor should keep in mind the "greater than 50 percent coverage" aspect of the metric. A simple way of measuring the depth of depressions is to lay a stick (auger, shovel, or branch) across depressions (see Photo 4.3.2.3-1) and approximate the height of the stick above ground surface. The optimum characteristics for this metric vary by general wetland type. (Maybe the vertical – 07-03-23-1619)

**4. Soil Texture/Structure – assessment area condition metric**

**Select all that apply. Dig soil profile in the dominant assessment area landscape feature. Make soil observations within the top foot. National Technical Committee for Hydric Soils field indicators of hydric soils are noted (use most recent guidance, http://soils.usda.gov/use/hydric/).**

- ☐ **A** Sandy soil
- ☐ **B** Predominantly characterized by mottled (redoxymorphic features), mineral soil
- ☐ **C** Predominantly characterized by other, mineral soil (no mottling)
- ☐ **D** Gleyed mineral soil
- ☐ **E** Soil ribbon < 1 inch
- ☐ **F** Soil ribbon ≥ 1 inch
- ☐ **G** No peat or muck presence
- ☐ **H** A peat or muck presence
- ☐ **I** Peat or muck soil (histosol or histic epipedon)

This metric addresses the Hydrology and Water Quality functions of forested wetland types. The assessor should only consider the assessment area when evaluating this metric and should select all descriptors that apply. As stated, the soil profile should be dug in the dominant landscape feature to look at the characteristic assessment area profile. Several holes may need to be excavated for the assessor to determine that this requirement has been met. Soil observations should be made within 12 inches of the surface unless best professional judgment indicates otherwise. Make note of reasoning if observations occur at a different depth. Soil texture should be determined through use of a texture decision chart (Appendix H). Soil colors are typically determined with the use of Munsell soil color charts (produced by GretagMacbeth – the 2000 edition includes 322 colors on 9 charts).

When utilizing the Field Indicators of Hydric Soils in the United States, if the top 6 inches of your soil sample is entirely sand or loamy sand, use the "S" indicators. If there are any loamy layers at all within the top 6 inches, use the "F" indicators. Note that the "A" indicators apply to all soils. "Mottles" refer to spots or blotches of different color or shades of color interspersed within the dominant color of a soil layer and are now referred to formally as redoximorphic concentrations and depletions. Mottles result from the presence of periodic reducing soil conditions. "Gleying" is a soil condition resulting from prolonged soil saturation, which is manifested by the presence of bluish or greenish colors through the soil mass or in mottles among other colors. "Peat" is a fibric organic soil material that has virtually all of the organic material allowing for identification of plant forms. "Muck" is an organic soil material in which

virtually all of the organic material is decomposed, not allowing for identification of plant forms. NRCS National Technical Committee on Hydric Soils field indicators of hydric soils are irregularly updated, so rather that provide a list of indicators with this manual, the assessor is advised to use the most recent guidance (http://soils.usda.gov/use/hydric/). The optimum characteristics for this metric vary by general wetland type.

**5. Discharge into Wetland – opportunity metric**

**Check a box in each column. Consider surface pollutants or discharges (Surf) and sub-surface pollutants or discharges (Sub). Examples of sub-surface discharges include presence of nearby septic tank, underground storage tank (UST), etc.**

| Surf | Sub | |
|---|---|---|
| ☐A | ☐A | **Little or no evidence of pollutants or discharges entering the assessment area** |
| ☐B | ☐B | **Noticeable evidence of pollutants or discharges entering the wetland and stressing, but not overwhelming the treatment capacity of the assessment area** |
| ☐C | ☐C | **Noticeable evidence of pollutants or discharges (pathogen, particulate, or soluble) entering the assessment area and potentially overwhelming the treatment capacity of the wetland (water discoloration, dead vegetation, excessive sedimentation)** |

The assessor should consider the assessment area only when evaluating this metric. Both surface (Surf) and sub-surface (Sub) discharge components address departure from reference of the Water Quality function for non-riverine wetlands, marshes, and Estuarine Woody Wetland. For the purposes of NC WAM, the term “pollutants” refers to substances introduced into the assessment area that adversely affect the usefulness or health of the wetland (for instance, salt may not be a pollutant in estuarine wetlands but is considered a pollutant in freshwater wetlands); the term “pathogen” refers to undesirable bacteria and viruses; the term “particulate” refers to sediment and insoluble organic matter in the water column; and the term “soluble” refers to dissolved materials from the water column (for example, nutrients that are readily water soluble, such as nitrate nitrogen). Examples of discharges may include stormwater from a point or a non-point discharge, sediment, and animal waste. Discharges do not necessarily have to be directly observed by the assessor if they can be inferred from other sources of information. For instance, estuarine wetlands that have been given the designation of “closed shellfish bed” may be inferred to be subject to a detrimental discharge. Wetlands subject to such designations should not receive a descriptor of “A.”

“Discharge into Wetland” is an opportunity metric that accounts for or infers watershed conditions affecting the level of performance of the Water Quality wetland function. “Opportunity” can increase the amount of water quality treatment a wetland provides by increasing the amount and types of discharges to which the wetland is exposed. Opportunity only leads to increased function if the wetland has the capacity for performing a higher level than reference function. In NC WAM, opportunity is used to modify the functional rating based on condition, with the combination of condition and opportunity metrics used to determine if the wetland has the capacity to respond to the opportunity.

**6. Land Use – opportunity metric**

**Check all that apply. Evaluation of this metric involves a GIS effort with field adjustment. Consider sources draining to assessment area within entire upstream watershed (WS), within 5 miles and within the watershed draining to the assessment area (5M), and within 2 miles and within the watershed draining to the assessment area (2M). Effective riparian buffers are considered to be 50 feet wide in the Coastal Plain and Piedmont ecoregions and 30 feet wide in the Blue Ridge Mountains ecoregion.**

| WS | 5M | 2M | |
|---|---|---|---|
| ☐A | ☐A | ☐A | > 30% impervious surfaces with stormwater Best Management Practices (BMPs) (land use examples: industrial, commercial, and high-density residential) |
| ☐B | ☐B | ☐B | > 30% impervious surfaces without stormwater BMPs |
| ☐C | ☐C | ☐C | 10 to 30% impervious surfaces |
| ☐D | ☐D | ☐D | < 10% impervious surfaces |
| ☐E | ☐E | ☐E | Old urban development (pink areas on USGS 7.5-minute quadrangles) |
| ☐F | ☐F | ☐F | New adjacent development |
| ☐G | ☐G | ☐G | Confined animal operations (or other local, concentrated source of pollutants) |
| ☐H | ☐H | ☐H | ≥ 20% coverage of pasture without riparian buffer |
| ☐I | ☐I | ☐I | ≥ 20% coverage of pasture with effective riparian buffer |
| ☐J | ☐J | ☐J | ≥ 20% coverage of agricultural land (regularly plowed land) without riparian buffer |
| ☐K | ☐K | ☐K | ≥ 20% coverage of agricultural land (regularly plowed land) with effective riparian buffer |
| ☐L | ☐L | ☐L | ≥ 20% coverage of maintained grass/herb |
| ☐M | ☐M | ☐M | Silvicultural land with disturbance < 5 years old |
| ☐N | ☐N | ☐N | Little or no opportunity. Lack of opportunity may result from hydrologic modifications that prevent drainage or overbank flow from affecting the assessment area. |

The assessor should consider three landscape areas relative to the assessment area when evaluating this metric: 1) the entire watershed draining to the assessment area (WS), 2) the area within 5 miles and within the watershed and draining to the assessment area (5M), and 3) the area within 2 miles and within the watershed and draining to the assessment area (2M). The entire watershed is considered with respect to the assessment area's opportunity to dissipate water energy (the physical change sub-function of the Water Quality function). The area within 5 miles and within the watershed draining to the assessment area is considered with respect to the assessment area's opportunity to remove sediments and attached pollutants (the particulate change sub-function of the Water Quality function) and to remove dissolved pollutants (the soluble change sub-function of the Water Quality function). The area within 2 miles and within the watershed draining to the assessment area is considered with respect to the assessment area's opportunity to remove bacteria and viruses (the pathogen change sub-function of the Water Quality function). The shorter distance of concern (2 miles) placed on pathogens is due to die-off of bacteria and viruses while traveling through the system.

The assessor may benefit from traveling through the watershed draining to the assessment area in order to gain first-hand information for the evaluation of this metric. However, the evaluation of this metric is expected to also involve a mapping investigation. Sources of information that may be used by the assessor to evaluate this metric include Geographic Information System (GIS) data (made available by the county or state), aerial photography, USGS topographic

mapping, county soils survey information, and land use/land cover mapping. These GIS data sources will all be characterized by a certain degree of error, and regulatory agencies acknowledge the existence of this error.

Most recent development can be considered to utilize Best Management Practices (BMPs); conversely, older development often does not utilize BMPs. Confined animal operations are facilities associated with production of animal products through the raising of livestock in large numbers in a limited space, resulting in the on-site concentration of animal byproducts. Livestock manure is considered a "pollutant" by NC WAM. An example of "other local, concentrated source of pollutants" is a landfill.

Appropriate riparian buffers are considered to be 50 feet wide in the Coastal Plain and Piedmont ecoregions and 30 feet wide in the Blue Ridge Mountains ecoregion. A breach in a buffer does not necessarily mean the buffer is ineffective. The extent of a breach necessary to reduce buffer effectiveness is left to the assessor's best professional judgment. Un-buffered agricultural or pastoral ditches draining to a buffered stream are considered to effectively bypass the riparian buffer.

Indications that an assessment area is not subject to watershed inputs (overbank events, runoff from adjacent areas) suggest the assessment area has little or no opportunity to provide aspects of the Water Quality function (example: a stream has been deepened and a berm has been established between the wetland and the stream so that overbank flooding [based on field evidence] rarely, if ever, occurs). Presence of sedimentation within the assessment area may indicate that the wetland is subject to watershed inputs.

This metric is concerned with conditions within the watershed that may enhance the "opportunity" of the assessment area to perform the Water Quality function. "Opportunity" can increase the amount of water quality treatment a wetland provides by increasing the amount and types of discharges the wetland is exposed to. Opportunity only leads to increased function if the wetland has the capacity for performing additional function. This metric is used in the assessment of Water Quality function for riverine wetlands.

**7. Wetland Acting as Vegetated Buffer – assessment area condition metric**

**Is the assessment area within 50 feet of a stream or other open water? ("open water" does not include man-made ditches or canals)**

**☐Yes ☐No If No, skip to next metric**

**Stream width (Stream width is normal flow width [ordinary high water to ordinary high water]). If the stream is anastomosed, combine widths of channels/braids for a total stream width.**

**☐≤ 15-feet wide ☐> 15-feet wide ☐Not Applicable**

**Do roots of assessment area vegetation extend into the bank of the adjacent stream/open water?**

**☐Yes ☐No**

**Is stream or other open water sheltered or exposed?**

**☐Sheltered – adjacent open water with width < 2500 feet and no regular boat traffic.**

**☐Exposed – adjacent open water with width ≥ 2500 feet or regular boat traffic.**

The assessor should consider the assessment area only when answering this metric. This metric addresses the Water Quality function in riverine wetlands.

"Open water" includes streams, rivers, natural or man-made ponds, natural or man-made lakes, estuaries, and the ocean, but does not normally include man-made ditches or canals. However, if a ditch or canal is large enough or the assessment area is providing a tangible bank stabilization function, evaluate the metric for the wetland – use best professional judgment, and document reasoning on the Field Assessment Form.

As stated in the metric, stream width is the normal flow width, or distance of ordinary high water on one bank to ordinary high water on the opposite bank that may be determined by the location of a bench, non-aquatic vegetation (see USACE Regulatory Guidance Letter No. 05-05 [Ordinary High Water Mark Identification] for guidance). If a stream consists of multiple channels (an anastomosed or braided system), combine the channel widths to estimate the total stream width.

If the assessment area is within 50 feet of a stream or open water, but has no surface hydrology connection (perhaps due to stream incision or separation by a wall or berm), then the assessor should select the first "No" and skip to the next metric (example: a stream has been deepened and a berm has been established between the wetland and the stream so that overbank flooding [based on field evidence] rarely, if ever, occurs). If an assessed wetland occurs within 50 feet of both a stream greater than 15 feet wide and a stream less than or equal to 15 feet wide, the assessor should use best professional judgment in determining which stream the wetland best serves in terms of buffer and flood-flow attenuation.

Roots of vegetation (both woody and herbaceous) extending into banks are considered to be an important factor in stabilizing bank sediments and preventing erosion and subsequent water quality degradation. This determination is made based on visual assessment.

Shorelines anticipated to be regularly subject to waves of a height of 1 foot or more are considered to be "exposed." NC WAM considers an open water width of 2500 feet to provide sufficient fetch for regular development of waves meeting or exceeding this threshold. Also, shorelines adjacent to open water with regular boat traffic that generates high-energy wakes are considered to be "exposed," regardless of the open-water width. Shorelines not anticipated to be regularly subject to waves of greater than 1 foot in height are considered to be "sheltered." NC WAM considers an open water width of less than 2500 feet to provide too little fetch for regular development of waves meeting or exceeding this threshold unless there is regular boat traffic.

**8. Wetland/Riparian Buffer Width – assessment area/wetland type/wetland complex metric**

**Check a box in each column. Select the appropriate width for the wetland type at the assessment area (WT), the wetland complex (WC), and the riparian buffer at the assessment area (RB) (if applicable). Riparian buffer width is measured from top of bank and need only be present on one side of the water body. The riparian buffer is measured from the outside banks of the outer channels of an anastomosed system. Make buffer judgment based on the dominant landscape feature. Record a note if a portion of the buffer has been removed or disturbed.**

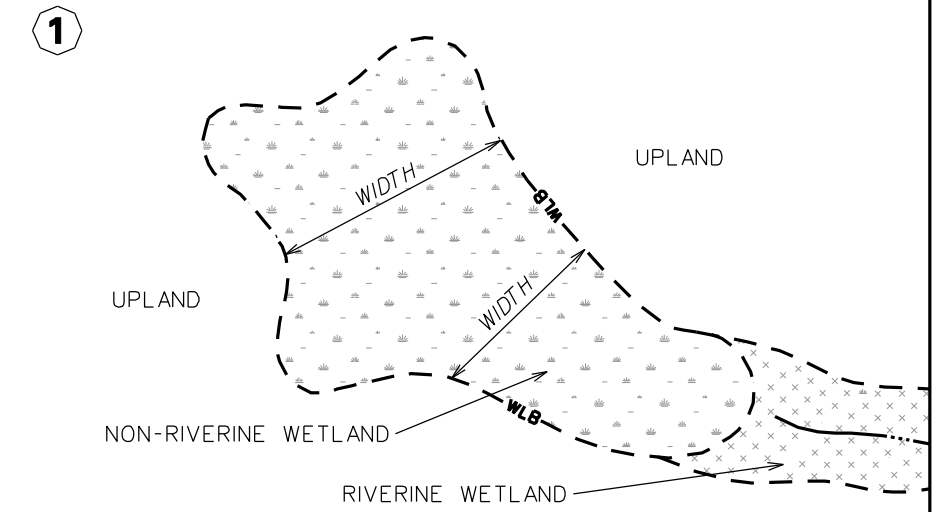
| WT | WC | RB (if applicable) | |
|---|---|---|---|
| ☐A | ☐A | ☐A | ≥ 100 feet |
| ☐B | ☐B | ☐B | From 80 to < 100 feet |
| ☐C | ☐C | ☐C | From 50 to < 80 feet |
| ☐D | ☐D | ☐D | From 40 to < 50 feet |
| ☐E | ☐E | ☐E | From 30 to < 40 feet |
| ☐F | ☐F | ☐F | From 15 to < 30 feet |
| ☐G | ☐G | ☐G | From 5 to < 15 feet |
| ☐H | ☐H | ☐H | < 5 feet |

The assessor needs to evaluate this metric for the wetland type at the assessment area (WT), the wetland complex (WC), and the riparian buffer at the assessment area (RB). This metric is used primarily in the Water Quality function and, to a lesser extent, in the Hydrology function in riverine wetlands and all marshes. The high number of options and odd intervals of the options presented in this metric are a result of different thresholds for different general wetland types.

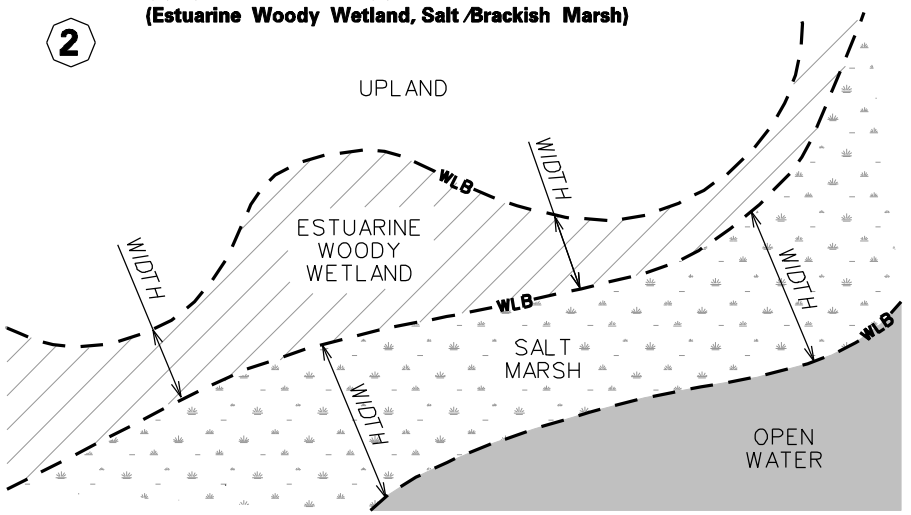
See Figure 4 for examples of how to determine wetland widths. When selecting the appropriate descriptor for wetland width of interstream or slope wetlands, choose an average along the narrowest axis of the wetland. For wetlands associated with a floodplain, linear conveyance, or a natural lake, measure width perpendicular to elevation contours, stream bank, or shoreline. The WFAT considers wetland width to be more important than wetland size with consideration to dissipation of wave energy for shoreline-fringing wetlands.

When evaluating wetlands in one of the 20 coastal counties covered by the N.C. Coastal Area Management Act (CAMA), the assessor should consider N.C. Division of Coastal Management (NCDCM) coastal wetlands as equivalent to wetlands as defined by Section 404 of the Clean

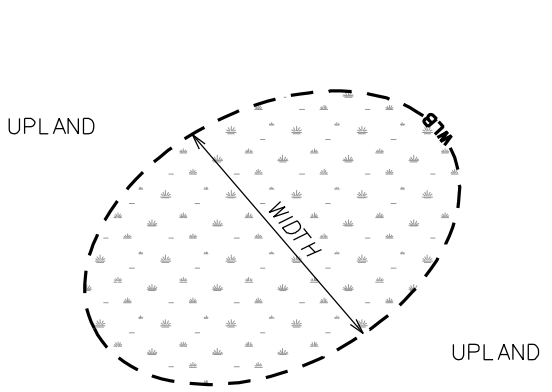
**EXAMPLE: INTERSTREAM FLAT WETLAND**



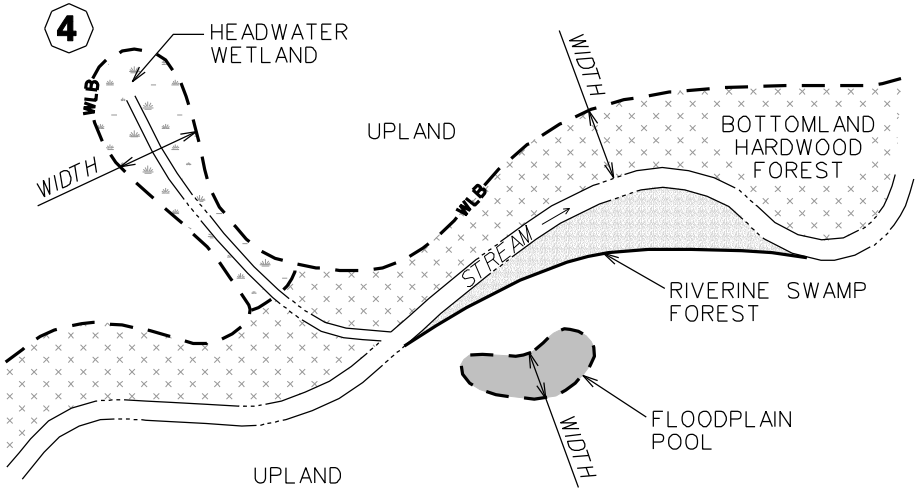

**EXAMPLE: COASTAL WETLAND COMPLEX**
**(Estuarine Woody Wetland, Salt /Brackish Marsh)**




**EXAMPLE: SMALL BASIN WETLAND (Carolina Bay)**




**EXAMPLE: RIVERINE WETLANDS**




NC WAM USER MANUAL

# EXAMPLE WETLAND WIDTH DETERMINATIONS

MAY 2007

FIGURE

4

Water Act. Note that CAMA wetlands need not be characterized by the three criteria typically used by the USACE for identifying Section 404 wetlands.

Estuarine Woody Wetlands range in shape from large expanses to relatively narrow, variable-width buffers between brackish or salt marshes and freshwater wetlands. When determining the width of Estuarine Woody Wetlands, the assessor should consider the width of this wetland type in the vicinity of the assessment area only. As with Estuarine Woody Wetland, the assessor should determine the marsh width in the vicinity of the assessment area. In the case of marshes, wetland width will be used by NC WAM to determine potential for the assessment area to dissipate wave energy.

The riparian buffer width component of this metric refers to "wetland" riparian buffer only and not to upland riparian buffer. The riparian buffer (RB) column need only be used if the assessed wetland is adjacent to a stream or other water body. For a multiple channel stream, the width of the riparian buffer should be measured up slope from the outermost channel on each side. The assessor should consider whether the majority of the wetland is acting as a riparian buffer. If only a portion of the wetland appears to be acting as a buffer, the assessor should only include this active wetland buffer in the assessment. The reasoning behind this decision should be noted on the Field Assessment Form.

A breach in a buffer does not necessarily mean the buffer is ineffective. The extent of a breach necessary to reduce buffer effectiveness is left to the assessor's best professional judgment. Un-buffered agricultural or pastoral ditches draining to a buffered stream are considered to be effectively bypassing the riparian buffer.

**9. Inundation Duration – assessment area condition metric**

**Answer for assessment area dominant landform.**

- ☐ **A** **Evidence of short-duration inundation (< 7 consecutive days)**
- ☐ **B** **Evidence of saturation, without evidence of inundation**
- ☐ **C** **Evidence of long-duration inundation (7 to 30 consecutive days or more)**

The assessor should consider the assessment area only when evaluating this metric. This metric addresses departure from reference of both the Hydrology and Water Quality functions of some riverine wetlands and Non-Tidal Freshwater Marsh.

The assessor should consider evidence of inundation during the growing season only. Although the USACE Wetland Delineation Manual (Environmental Laboratory 1987) lists wetland hydrology indicators, the manual provides no guidance for separating the three categories evaluated by this metric. The assessor will need to rely on on-site evidence and best professional judgment. Presence of emergent vegetation (Appendix E) or lack of ground cover in combination with water marks on fixed objects or silt- or water-stained leaves may be evidence of long-duration inundation. Presence of facultative or water-tolerant plant species in

combination with wetland hydrology indicators (observation of inundation, watermarks, drift lines, sediment deposits, drainage patterns within wetlands, and water-stained leaves) may be evidence of short-duration inundation. Presence of facultative or water-tolerant plant species in conjunction with wetland soils and the absence of evidence of surface water may suggest saturation without inundation.

In the Coastal Plain ecoregions, mineral soils typically should not be characterized by long-duration inundation unless the wetland is Riverine Swamp Forest or Non-Riverine Swamp Forest. A wetland located on a mineral soil that appears to be subject to long-duration inundation may be subject to a hydrological alteration of some sort.

**10. Indicators of Deposition – assessment area condition metric**

**Consider recent deposition only (no plant growth since deposition).**

**☐A Sediment deposition is not excessive, but at approximately natural levels.**
**☐B Sediment deposition is excessive, but not overwhelming the wetland.**
**☐C Sediment deposition is excessive and is overwhelming the wetland.**

The assessor should consider only the assessment area when evaluating this metric. This metric addresses the departure from reference of the Water Quality function in forested, riverine wetland types only. The term "recent deposition" refers to sediment deposited by moving water that has not been in place long enough for vegetation to become established in it. The term "overwhelming the wetland" refers to conditions resulting in loss of vegetation components or wetland hydrology.

**11. Wetland Size – wetland type/wetland complex condition metric**

**Check a box in each column. Involves a GIS effort with field adjustment. This metric evaluates three aspects of the wetland area: the size of the wetland type (WT), the size of the contiguous wetland complex (WC), and the size of the contiguous, forested wetland (FW) (if applicable, see User Manual). Boundaries are formed by uplands, four-lane roads, or urban landscapes. An observed beaver pond forms a boundary if it extends across the entire width of the floodplain. Additionally, other wetland types are considered boundaries for Column WT. If assessment area is clear-cut, select "K" for the FW column.**

| WT | WC | FW (if applicable) | |
|---|---|---|---|
| ☐A | ☐A | ☐A | ≥ 500 acres |
| ☐B | ☐B | ☐B | From 100 to < 500 acres |
| ☐C | ☐C | ☐C | From 50 to < 100 acres |
| ☐D | ☐D | ☐D | From 25 to < 50 acres |
| ☐E | ☐E | ☐E | From 10 to < 25 acres |
| ☐F | ☐F | ☐F | From 5 to < 10 acres |
| ☐G | ☐G | ☐G | From 1 to < 5 acres |
| ☐H | ☐H | ☐H | From 0.5 to < 1 acre |
| ☐I | ☐I | ☐I | From 0.1 to < 0.5 acre |
| ☐J | ☐J | ☐J | From 0.01 to < 0.1 acre |
| ☐K | ☐K | ☐K | < 0.01 acre |

The assessor needs to evaluate this metric for the wetland type at the assessment area (WT), the wetland complex (WC), and the forested wetland contiguous with the assessment area (FW). This metric is principal to the assessment because it addresses the departure from reference of all three wetland functions and is used in the functional assessment of all general wetland types. This metric is used to assess the Water Quality function of non-riverine wetland types and the Habitat function of all wetland types. In the case of Estuarine Woody Wetland, this metric is used to assess the Hydrology function. The number of metric options and odd intervals of the metric options are the result of compiling different thresholds for different general wetland types. The "forested wetland" column will only be used if the assessment area occurs in a forested wetland type. If the assessment area is a forested wetland type that has been clear-cut, the assessor should select "K" for the "forested wetland" column.

Depending on the size of the assessment area, wetland type, and wetland complex, the evaluation of this metric may a mapping investigation. Sources of information that may be used by the assessor to evaluate this metric include Geographic Information System (GIS) data (made available by the county or state), aerial photography, USGS topographic mapping, county soils mapping, and land use/land cover mapping. A good deal of best professional judgment may be required for this task.

**12. Wetland Intactness – wetland type condition metric (evaluate for Pocosins only)**

☐**A** **Wetland type is the full extent (≥ 90%) of its natural landscape size.**
☐**B** **Wetland type is < 90% of the full extent of its natural landscape size.**

4.3.2.12-1

4.3.2.12-2

Photo 4.3.2.12-1 depicts a Carolina bay that appears to be less than the full extent of its original landscape size but is likely greater than 90 percent of its natural landscape size, while Photo 4.3.2.12-2 depicts a Carolina bay that has been modified to be less than 90 percent of its natural landscape size (photographs courtesy George A. Howard).

The assessor should consider the wetland type when evaluating this metric. This metric addresses the departure from reference of the Habitat function for Pocosin only. The evaluation of this metric is expected to involve best professional judgment and a map investigation. County soils mapping may be the best source of information for estimation of "landscape size." Appendix D provides a list of soils (generated by the NCDCM) that typically support Pocosin. A Pocosin not occupying the full extent of the mapped Pocosin soil unit may have suffered some disturbance that has reduced it from its natural landscape size. Other sources of information may include Geographic Information System (GIS) data (made available by the county or state), aerial photography, USGS topographic mapping, and land use/land cover mapping).

**13. Connectivity to Other Natural Areas – landscape condition metric**

**Check appropriate box(es). This metric refers to the landscape patch, the contiguous naturally vegetated area and open water (if appropriate) that include the wetland type. Boundaries are formed by four-lane roads, urban landscapes, maintained fields (pasture and agriculture), or open water > 300 feet wide. Consider if the wetland type is well-connected (WC) or loosely-connected (LC) to the landscape patch.**

| WC | LC | |
|---|---|---|
| ☐A | ☐A | ≥ 500 acres |
| ☐B | ☐B | From 100 to < 500 acres |
| ☐C | ☐C | From 50 to < 100 acres |
| ☐D | ☐D | From 10 to < 50 acres |
| ☐E | ☐E | < 10 acres |
| ☐F | ☐F | Wetland type has a poor or no connection to other natural habitats |

**Check Yes or No.**

| | | |
|---|---|---|
| ☐Yes | ☐No | Does wetland type have a surface hydrology connection to open waters or tidal wetlands? |
| ☐Yes | ☐No | Is the assessment area subject to overbank flooding during normal conditions? |

The assessor should consider the regional landscape when evaluating this metric. This metric addresses the juxtaposition of other naturally vegetated areas relative to the assessment area. This metric applies to the Habitat function of all general wetland types.

"Well connected" (WC) is a term that generally refers to a wetland type that is surrounded by or adjoins a natural habitat patch along a substantial part of its boundary on at least one side. A wetland type is considered to be "loosely connected" (LC) to other natural habitats if connected by narrow corridors of natural habitat or by broader corridors of unnatural habitats through which wildlife may pass, such as pine plantations or mosaics of cropland and woodland. Boundaries must present a barrier or danger to wildlife attempting to negotiate them in order to disconnect the assessment area from adjacent or nearby natural areas. Such boundaries include four-lane roads, urban landscapes, maintained fields, or open water greater than 300 feet wide.

"Surface hydrology connection to open waters or tidal wetlands" is an important factor in the evaluation of the Habitat function in marshes. When evaluating marshes, an assessor should only consider other marsh-like areas in terms of connection to natural areas. "Marsh-like areas" include emergent herbs and shrubs with or without an interspersion of surface water. This metric is concerned with the potential for movement of wildlife and fish among contiguous,

suitable habitat types, and wetland types found higher in the landscape would likely not provide suitable habitat for many marsh specialists. In this sense, a "surface hydrology connection" includes any type of connection that will allow aquatic life movement. A ditch or canal is only considered to be a surface hydrology connection if it has been determined to be subject to Section 404 jurisdiction. A marsh is still considered to have a surface hydrology connection to other natural areas if culverts allow aquatic life access into and out of the wetland. The assessor should document best professional judgment concerning the evaluation of this metric when the assessed wetland is on an island.

Wetlands located near streams or other open waters are not necessarily subject to overbank flooding from those water bodies. The assessor is requested to use best professional judgment to determine whether the assessment area is subject to overbank flooding during normal conditions. Indicators of overbank events during normal conditions includes recent sedimentation, water lines, debris lines, reclining vegetation, and gauge data. "Normal conditions" is not considered to include severe, aperiodic events such as hurricanes.

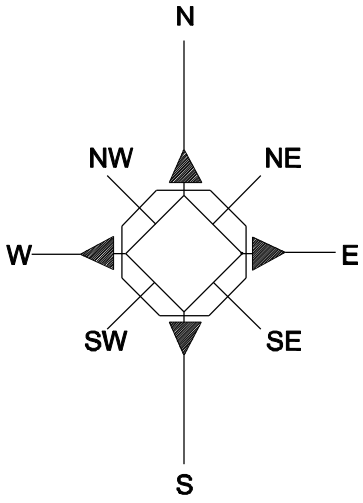
**14. Edge Effect – wetland type condition metric**

**Estimate distance from wetland type boundary to artificial edges. Artificial edges include permanent features such as fields, development, two-lane or larger roads (≥ 40-feet wide), utility line corridors wider than a two-lane road, and clear-cuts < 10 years old. Consider the eight main points of the compass.**

☐**A** **No artificial edge within 150 feet in all directions**
☐**B** **No artificial edge within 150 feet in four to seven directions**
☐**C** **An artificial edge occurs within 150 feet in more than four directions or assessment area is clear-cut**

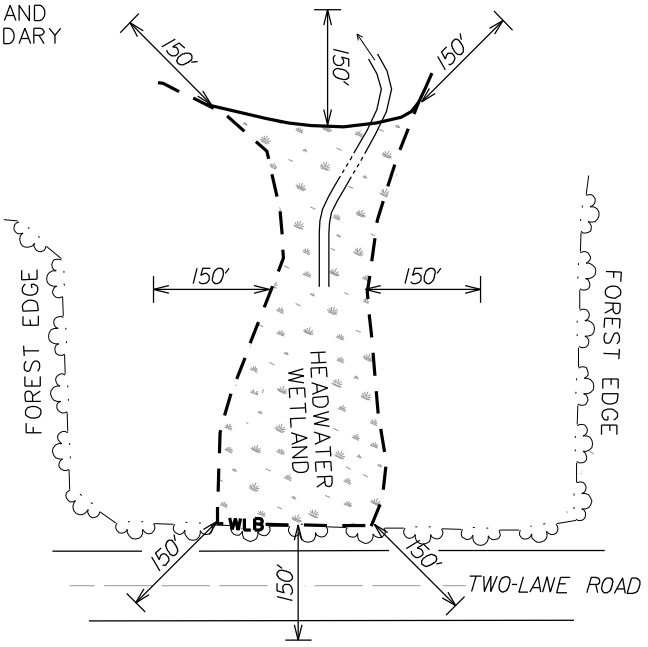
The assessor should consider the wetland type when evaluating this metric. This metric addresses the departure from reference of the Habitat function for all forested wetland types. The listed artificial edges include areas that break the structure of forested wetlands (forested uplands are not considered an artificial edge). Artificial edges are barriers to travel or population expansion for some native flora and fauna, yet provide access to forest interiors for invasive and exotic fauna and flora. If the assessment area has been recently clear-cut (within the past 10 years) this metric will receive a descriptor of "C."

The eight main points of the compass comprise north, northeast, east, southeast, south, southwest, west, and northwest. Figure 5 provides a display of the eight main points of the compass and depicts two proposed activities, A and B. These activities are represented with emphasis on the issue of artificial edge. The wetland type included in proposed activity A assessment area (Headwater Wetland) is characterized by artificial edge within 150 feet in only three directions (southeast, south, and southwest), resulting in a descriptor of "B." The wetland type included in proposed activity B assessment area (Hardwood Flat) is characterized by artificial edge within 150 feet in all directions, resulting in a descriptor of "C."




EIGHT MAIN POINTS OF THE COMPASS

— -WLB— - WETLAND BOUNDARY




WETLAND TYPE: HEADWATER WETLAND

**METRIC # 14-B:**

**No Artificial Edge Within 150 Feet In Four To Seven Directions.**

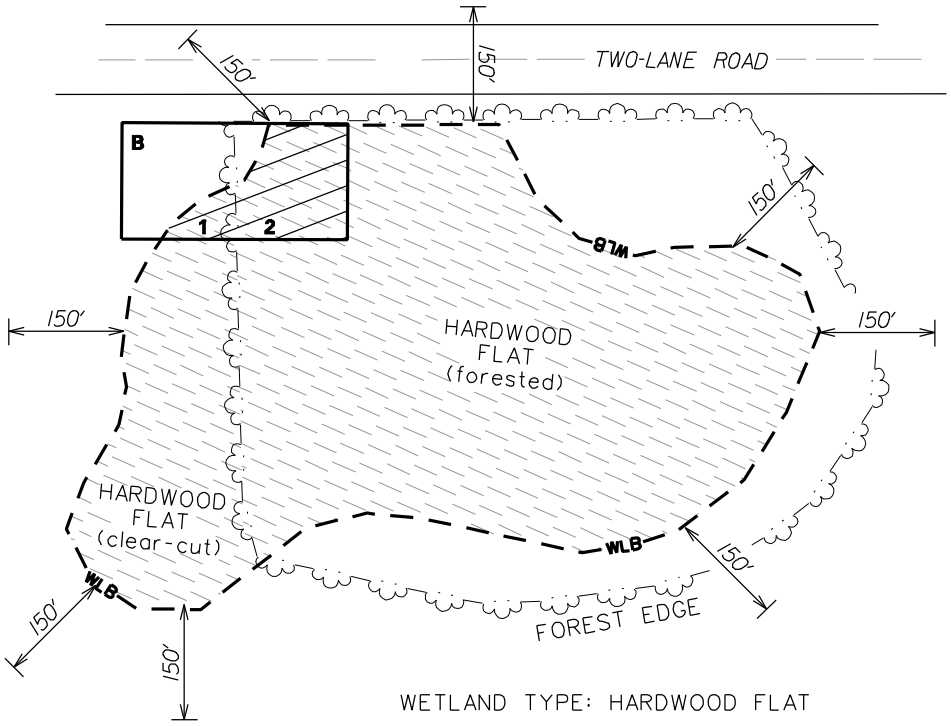
SCALE: NTS

PROPOSED ACTIVITY

ASSESSMENT AREA

— -WLB— - WETLAND BOUNDARY

SCALE: NTS




WETLAND TYPE: HARDWOOD FLAT

**METRIC # 14-C:**

**An Artificial Edge Occurs Within 150 Feet In More Than Four Directions.**

NC WAM USER MANUAL

# EXAMPLE ARTIFICIAL EDGE

MAY 2007

FIGURE

**5**


4.3.2.14-1

4.3.2.14-2

Photos 4.3.2.14-1 and 4.3.2.14-2 are examples of artificial edges. Photo 4.3.2.14-1 depicts a greater than 200-feet wide maintained utility line corridor extending through a Pocosin in Brunswick County. Photo 4.3.2.14-2 depicts a maintained road, man-made ditch (together, wider than a two-lane road) adjacent to a Pine Flat in Craven County.

Photos 4.3.2.14-3 and 4.3.2.14-4 depict maintained corridors in Brunswick County. Photo 4.3.2.14-3 is an example of an artificial edge because the maintained corridor is wider than the width of a two-lane road, while Photo 4.3.2.14-4 is not an example of an artificial edge because the maintained corridor is the width of a two-lane road or narrower.


4.3.2.14-3


4.3.2.14-4

**15. Vegetative Composition – assessment area condition metric (skip for marshes and Pine Flat)**

- ☐**A** **Vegetation is close to reference condition in species present and their proportions. Lower strata composed of appropriate species, with exotic plants absent or sparse within the assessment area.**
- ☐**B** **Vegetation is different from reference condition in species diversity or proportions, but still largely composed of native species characteristic of the wetland type. This may include communities of weedy native species that develop after clear-cutting or clearing. It also includes communities with exotics present, but not dominant, over a large portion of the expected strata.**
- ☐**C** **Vegetation severely altered from reference in composition. Expected strata are unnaturally absent or dominated by exotic species or composed of planted stands of non-characteristic species or inappropriately composed of a single species.**

The assessor should consider the assessment area only when evaluating this metric. This metric addresses the departure from reference of the Habitat function for all general wetland types with the exception of marshes and Pine Flat. In order to evaluate this metric, the assessor needs to be familiar with the structure and composition of vegetation within the range of reference examples of each general wetland type. Exotic species may become established in disturbed areas, so the presence of exotic species suggests a past disturbance which resulted in a window of opportunity for establishment. A list of species considered to be exotic in North Carolina is provided in Appendix I. Although not on the list of exotics, common reed (*Phragmites australis*) is considered a non-native, invasive species in North Carolina marshes, and presence of this species should be considered equivalent to presence of an exotic.

**16. Vegetative Diversity – assessment area condition metric (evaluate for Non-Tidal Freshwater Marsh only)**

- ☐**A** **Vegetation diversity is high and is composed primarily of native species.**
- ☐**B** **Vegetation diversity is low or has > 10% cover of exotics.**
- ☐**C** **Vegetation is dominated by exotic species.**

The assessor should consider the assessment area only when evaluating this metric. This metric is used in the Habitat function in Non-tidal Freshwater Marsh only. An estimation of percent coverage of vegetation should be made for the growing season. Exotic species usually become established in disturbed areas, so the presence of exotic species may suggest a past disturbance which resulted in a window of opportunity for establishment. A list of species considered to be exotic in North Carolina is provided in Appendix I. Although not on the list of exotics, common reed (*Phragmites australis*) is considered a non-native, invasive species in North Carolina marshes, and presence of this species should be considered equivalent to presence of an exotic.

**17. Vegetative Structure – assessment area/wetland type condition metric**

☐ **Vegetation present**

**Evaluate percent coverage of vegetation for marshes only**

☐**A** **≥ 25% coverage of vegetation**

☐**B** **< 25% coverage of vegetation**

**Check a box in each column for each stratum. Evaluate this portion of the metric for non-marsh wetlands. Consider structure in airspace above the assessment area (AA) and the wetland type (WT) separately.**

| AA | WT | |
|---|---|---|
| ☐A | ☐A | **Canopy closed, or nearly closed, with natural gaps associated with natural processes** |
| ☐B | ☐B | **Canopy present, but opened more than natural gaps** |
| ☐C | ☐C | **Canopy sparse or absent** |
| ☐A | ☐A | **Dense mid-story/sapling layer** |
| ☐B | ☐B | **Moderate density mid-story/sapling layer** |
| ☐C | ☐C | **Mid-story/sapling layer sparse or absent** |
| ☐A | ☐A | **Dense shrub layer** |
| ☐B | ☐B | **Moderate density shrub layer** |
| ☐C | ☐C | **Shrub layer sparse or absent** |
| ☐A | ☐A | **Dense herb layer** |
| ☐B | ☐B | **Moderate density herb layer** |
| ☐C | ☐C | **Herb layer sparse or absent** |

☐ **Vegetation absent**

The assessor should consider both the assessment area and the wetland type when evaluating this metric. This metric addresses the departure from reference for all three wetland functions. In order to evaluate this metric, the assessor needs to be familiar with the expected vegetation structure characteristic of the range of reference examples of each general wetland type. The question concerning percent coverage of vegetation is used in the assessment of the Water Quality function for marshes. Woody structure is important in riverine wetlands for slowing flood waters and overland runoff (Hydrology function) and increasing residence time for treatment and infiltration of surface waters (Water Quality function). Woody structure, at appropriate density and stratification for specific general wetland types, is important in terms of diversity of habitats (Habitat function). "Natural gaps associated with natural processes" includes large gaps resulting from natural tree fall as well as storm damage, including hurricane damage. In the case of Pine Savannas, large canopy gaps are characteristic of the natural structure of this wetland type, and, as such, the assessor needs to use best professional judgment to determine if the canopy gaps of a Pine Savanna are natural or the result of a disturbance such as logging.

Photo 3.1.6-2 depicts a Hardwood Flat recovering from hurricane damage. Although canopy gaps are larger than typical for reference of this wetland type, a hurricane is considered to be a natural process, and therefore "canopy closed or nearly closed, with natural gaps associated with natural processes" (descriptor A) is an appropriate descriptor. In this same example, the mid-story/sapling layer is sparse or absent (descriptor C), while the shrub and herb layers are

responding to increased sunlight since the hurricane, resulting in descriptors of “B” and “A,” respectively, for these layers.

**18. Snags – wetland type condition metric**

☐**A** **Large snags (more than one) are present (> 12-inches DBH, or large relative to species present and landscape stability).**

☐**B** **Not A**

The assessor should consider the wetland type when evaluating this metric. This metric addresses the departure from reference of the Habitat function for forested wetland types. Diameter at breast height (DBH) is the width of a plant stem as measured at 4.5 feet above the ground surface. The term “large” used in this metric should be considered relative to the species present in the assessment area (see Photo 4.3.2.18-1). For example: a stand of 8- to 10-inch DBH black willows (*Salix nigra*) is less than the 12-inch DBH criteria listed in the metric, but these trees are considered “large” for this species. “Landscape stability” refers to wetlands subject to disturbance or somehow lacking stability – such as a wetlands located at stormwater outfalls or on deltas at the head of reservoirs. More than one large snag should be visible to the assessor within the assessment area for the descriptor to be “A.” This is a “value-added metric;” a metric descriptor of “A” may increase a wetland rating for Habitat, while a metric descriptor of “B” will not affect the rating.

Photo 4.3.2.18-1 depicts both a large snag and large woody debris in a Pine Flat.

4.3.2.18-1

**19. Diameter Class Distribution – wetland type condition metric**

- ☐**A** **Most canopy trees have stems > 6-inches in diameter at breast height (DBH); many large trees (> 12-inches DBH) are present.**
- ☐**B** **Most canopy trees have stems between 6- and 12-inches DBH, few are > 12-inch DBH.**
- ☐**C** **Most canopy trees are < 6-inches DBH or no trees.**

The assessor should consider the wetland type when evaluating this metric. This metric addresses the departure from reference of the Habitat function for forested wetland types. DBH (diameter at breast height) is the width of a plant stem as measured at 4.5 feet above the ground surface. For this metric, canopy tree size is a surrogate estimate for habitat diversity – with the presence of larger trees considered indicative of higher structural diversity. The term "large" used in this metric should be considered relative to the species present in the assessment area. For example: a stand of 8- to 10-inch DBH black willows (*Salix nigra*) is less than the 12-inch DBH criteria listed in the metric, but these trees are considered "large" for this species.

**20. Large Woody Debris – wetland type condition metric**

**Include both man-made and natural debris piles.**

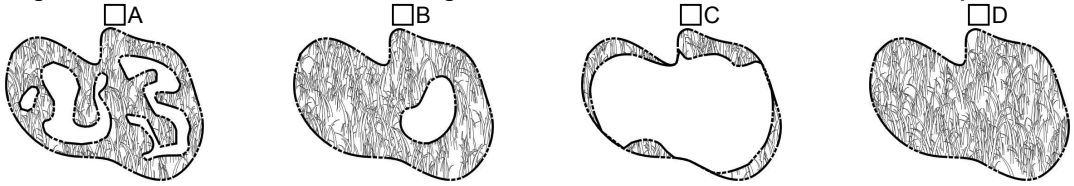
- ☐**A** **Large logs (more than one) are present (> 12-inches in diameter, or large relative to species present and landscape stability).**
- ☐**B** **Not A**

The assessor should consider the wetland type when evaluating this metric. This metric addresses the departure from reference of the Habitat function in forested wetland types only. The term "large" used in this metric should be considered relative to the species present in the assessment area (see Photo 4.3.2.18-1). For example: a stand of 8- to 10-inch diameter black willow trunks are less than the 12-inch criteria listed in the metric, but these trees are considered "large" for this species. An example of woody debris being large relative to landscape position might include Estuarine Woody Wetland, a transitional wetland type that might not be expected to provide a stable enough environment to support large trees. More than one large log should be visible to the assessor within the assessment area for the descriptor to be "A." This is a "value-added metric;" a metric descriptor of "A" may increase a wetland rating for Habitat, while a metric descriptor of "B" will not affect the rating.

**21. Vegetation/Open Water Dispersion – wetland type/open water condition metric (evaluate for Non-Tidal Freshwater Marsh only)**

**Select the figure that best describes the amount of interspersion between vegetation and open water in the growing season. Patterned areas indicate vegetated areas, while solid white areas indicate open water.**

☐A ☐B ☐C ☐D



The assessor should consider the wetland type when evaluating this metric. This metric is only used in the Habitat function in Non-tidal Freshwater Marsh. The evaluation of this metric should be made for the expected condition during the growing season. The assessor should consider open water 6.6 feet deep or shallower as part of this wetland. This depth represents the approximate maximum depth of non-persistent emergent vegetation as referenced by Cowardin et al. (1979). The assessor should not consider open water greater than 6.6 feet deep as part of this wetland. See Photos 4.3.2.21-1 through 4.3.2.21-4 on the next page for field examples of different descriptors.

**22. Habitat Uniqueness – assessment area condition metric**

☐**Yes** ☐**No** Has the N.C. Environmental Management Commission (EMC) classified the assessment area as "Unique Wetlands" (UWL)?"

The assessor should consider the assessment area when evaluating this metric. The appropriate descriptor for this metric will be made by reviewing the list of wetlands classified by the EMC as "Unique Wetlands" (UWL).

4.3.2.21-1

4.3.2.21-2

Photos 4.3.2.21-1, 4.3.2.21-2, 4.3.2.21-3, and 4.3.2.21-4 depict marshes in Henderson, Wake, Wake, and Brunswick counties, respectively. The first three include open water less than 6.6 feet deep within the wetland. Photo 4.3.2.21-1 depicts a homogenous interspersion of marsh vegetation and shallow open water – representing an example of Metric 21, descriptor A. Photo 4.3.2.21-2 depicts a relatively large area of marsh and a relatively small area of shallow open water – representing an example of Metric 21, descriptor B. Photo 4.3.2.21-3 depicts a narrow fringe of marsh around the perimeter of a relatively large open-water area – representing an example of Metric 21, descriptor C. And Photo 4.3.2.21-4 depicts a marsh with almost complete coverage by emergent and aquatic vegetation – representing an example of Metric 21, descriptor D.

4.3.2.21-3

4.3.2.21-4

## 5.0 THE WETLAND ASSESSMENT PROCESS

It is important that the assessor become familiar with the NC WAM general wetland types and Field Assessment Form metrics in order to conduct a proper wetland assessment. Assessors will need to be familiar with the physiography, hydrologic regime, water quality function, typical vegetation structure and composition, and wildlife attributes for the range of reference examples appropriate to each general wetland type associated with the project area. Assessors will also need to develop a clear understanding of the intention of each metric, how the intention of each metric may change with different general wetland types, and how characteristics within each wetland type may change among different ecoregions.

An on-going objective during development of NC WAM is that on-site completion of the Field Assessment Form should take no more than 15 minutes. However, it is assumed that this 15-minute, on-site wetland assessment will be performed following a wetland delineation or determination, and that during the course of the delineation/determination, the assessor will have become knowledgeable of the environmental features important to this wetland assessment method. This being the case, the assessor should have become familiar with site and regional physiography, soils, hydrology, vegetation, wetlands, and watershed activities affecting the site. The assessor should also be familiar with the proposed project in order to determine potential impact areas and identify individual assessment areas.

Completion of a wetland functional assessment will typically be a five-step process (the first three steps will likely be completed as part of a wetland delineation/determination but are outlined here to maintain continuity in the discussion of information sources and methods): 1) become familiar with regional features through off-site research (mostly map analysis); 2) conduct an on-site investigation sufficient to delineate separate general wetland types; 3) make a determination of the boundaries of one or more assessment areas within the proposed project or action area; 4) conduct a rapid, on-site evaluation of each assessment area; and 5) use the NC WAM rating calculator computer program to generate assessment ratings. Assessors are urged to document the basis for judgments on the Field Assessment Form or attach information for future reference by regulatory personnel and the public.

### 5.1 Background Information

Tools available for the assessor to become familiar with regional features may include the following.

- Aerial photography
- Topographic mapping
- County soil survey
- Wetlands mapping
- Land-use mapping

- Natural heritage element occurrence mapping
- NC WAM tool box (see description below and in Appendix J)

Wetland assessors should examine available natural resource data prior to making the field visit. Available resources to be consulted include (but are not limited to) aerial photography, topographic mapping (USGS 7.5-minute quadrangles or more accurate mapping if available), the county soil survey, U.S. Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) maps, the N.C. Division of Coastal Management (NCDCM) wetland map (if the site to be assessed is in the Coastal Plain ecoregions), NCNHP mapping of significant natural heritage areas and reference wetlands, local municipal web-based Information Mapping System (IMS) or GIS data sets (photography, contours, zoning, parcel data, etc.), and (if available) previously conducted jurisdictional area delineations from the project vicinity. These resources should initially be viewed with an eye toward landscape/watershed scale features. Next, the assessor should consider how potential wetland characteristics of the assessment site fit into the landscape perspective. The assessor should evaluate features of interest such as wetland delineation criteria (vegetation, hydrology, and soils) and anthropogenic disturbances (roadways, impoundments, deforestation, impermeable surfaces, and storm-water sources).

Another important tool for the wetland assessor (which utilizes much of the above-mentioned reference materials), currently under development, is a suite of GIS data layers collectively known by the working name “tool box.” A user guide for the tool box is provided in Appendix J. The tool box is intended to provide specific information concerning wetland sites previously evaluated, including locations and descriptions for reference examples of WFAT-identified wetland types. The tool box will contain a map of North Carolina subdivided into level III and IV ecoregions (Appendix F). Ideally, a queried ecoregion will provide the assessor with a location map of previously identified and assessed wetlands. Digital files of available natural resources information pertinent to the assessment of that wetland will be linked to each wetland assessment site - topographic mapping, aerial photography, soils mapping, NWI mapping, on-site photography, and a completed Field Assessment Form. By comparing digital data layers for the wetland area to be assessed with the reference information contained in the tool box, an assessor should be able to make a reasonable estimation of wetland types which may be encountered. As future assessments are performed and compiled, the tool box will be supplemented with the intent to expand wetland functional information for each wetland type over a range of levels of disturbance. This feature may 1) assist the assessor with identification of wetlands in substantially disturbed condition and 2) provide the assessor with a reference wetland functional rating based on a documented, previously rated wetland with a similar level of disturbance.

Information gathered during this task might be used to plan the assessor’s course of travel to the wetland assessment site to maximize the assessor’s knowledge and understanding concerning natural features in the region.

## 5.2 On-site Investigation

This discussion assumes the assessor has conducted a wetland delineation/determination (or is relying on a pre-existing wetland delineation/determination) and knows that wetlands are present in a project area.

Following a delineation/determination effort that results in the identification of wetlands within a project area, an assessor will need to 1) determine if wetland stressors are present, 2) determine if more than one wetland type is present, and, if so, identify wetland type boundaries, and 3) identify assessment areas for evaluation.

### 5.2.1 Presence of Wetland Stressors

During the on-site investigation, the assessor should make note of the presence of wetland stressors and consider the effect of stressors on project area wetlands. Wetland stressors include typically anthropogenic activities that affect one or more wetland functions. Potential wetland stressors may include, but are not limited to, ground surface disturbances, vegetation removal or maintenance, hydrological modification (stormwater runoff, ditching), presence of infrastructure which fragments habitat (roads, utility lines), and septic fields (see Section 2.3). The assessor should be familiar with the N.C. Scope and Affect Guide (Appendix G) to analyze the affects of ditches in hydric soils. The effect of a stressor on a wetland depends on the wetland type and size, stressor type and severity, and the amount of time the wetland has been subject to the stressor. In some cases, when given sufficient time, a wetland may adjust to one or more stressors by shifting to another general wetland type.

### 5.2.2 Wetland Type Identification

#### 5.2.2.1 Wetland Type, Number, and Size

NC WAM is designed for the assessor to consider current wetland condition during wetland type identification. The assessor should identify each discrete general wetland type that occurs within the project area using knowledge of the general wetland type descriptions (see Section 3.1) and the dichotomous key to general wetland types (see forms at the beginning of the User Manual [current version 5.13, October 9, 2006] and Section 3.4). It is important that the assessor walk the entire project area prior to making a wetland type determination or deciding if more than one wetland type is present. In cases where identification of the general wetland type is difficult, and a wetland appears to potentially fit into more than one general wetland type, the assessor should use best professional judgment in making the decision and provide documentation for the reasons. The assessor may choose to rate an assessment area as more than one wetland type and use best professional judgment to evaluate the results.

It is important that an assessor determine all boundaries between the wetland to be assessed (assessment area) and other wetland types or uplands. If the project area contains more than one wetland type, a determination of transition boundaries will need to be made. Depending on wetland types involved, the boundary between an assessment area and other wetland types

may be straightforward or problematic. When problematic, the assessor will need to use best professional judgment in boundary determination and provide written justification on the Field Assessment Form or attached map. Examples of problematic areas include 1) the boundary between Riverine Swamp Forest and Non-Riverine Swamp Forest in a large floodplain swamp system in the embayed region of the state, 2) the boundary between Headwater Wetland and Bottomland Hardwood Forest in a Piedmont floodplain at the confluence of a first-order tributary with a second-order tributary (see Figure 2), 3) the boundary between Pine Flat and Hardwood Flat on an interstream system in the Coastal Plain ecoregions, and 4) the boundary between an interstream wetland (examples: Pocosin, Pine Flat, Hardwood Flat) and a riverine wetland such as a Headwater Wetland. The NC WAM Tool Box will provide assessors with guidance concerning these types of problems.

#### 5.2.2.2 Wetland Type Identification in Disturbed Areas

All wetlands should be evaluated in the context of their landscape setting and recent history. Wetlands that have been subject to disturbance may be identified as degraded examples of general wetland types and/or as "intensively managed" wetlands on the Field Assessment Form. If identified as intensively managed, the subject wetland should still be identified as the appropriate general wetland type using the dichotomous key. The following working rule will assist the assessor with the identification of wetland type in confusing, substantially modified, or disturbed situations.

> Wetlands with modifications should generally be classified as the original, naturally occurring type if this determination can be made. However, if the full range of stable, existing wetland characteristics (vegetation, hydrology, and soils) better resemble another wetland type because of long-established, permanent alterations, it should be classified as this current, more appropriate type.

NC WAM considers the term "long-established, permanent alterations" to refer to alterations that have been ongoing for 10 or more years. In some cases, modifications or disturbances to wetlands may result in a change in wetland type. Specifically, modifications that substantially affect primary wetland characteristics often result in a change in wetland type. Examples of such modifications include deliberately constructed, man-made impoundments and excavations. Beaver impoundments are generally not thought to result in wetland type change in the short term (less than 10 years), but are expected to result in wetland type change over the long term (if established for 10 years or more). Examples of modifications not expected to result in a change in wetland type include unintentional, man-made impoundments, stormwater inputs, and cutovers. If a wetland has been disturbed but appears to be in a stable condition and progressing toward recovery, then the assessor should use the general wetland type key to identify the wetland type based on current conditions.

If a wetland has been disturbed to the point that identification of the general type is problematic, the assessor may look at area mapping (aerial photography, topographic mapping, soils

mapping, and the tool box) to see if there are nearby areas with similar characteristics which may provide a clue as to the proper wetland type. If the decision between wetland types remains unclear, the assessor may choose to rate a wetland as both possible wetland types and use best professional judgment to determine which rating best approximates the specific wetland (the Wetland Rating Sheet for both possible wetland types should be submitted to regulatory agencies for review). Wetlands in urban settings should be identified as the appropriate general wetland type and rated relative to reference examples of the general wetland type. NC WAM does not consider separate reference examples for urban wetlands.

It is anticipated that assessors will encounter wetlands of a single type characterized by more than one level of modification or disturbance. Examples of this include 1) a Hardwood Flat transected by a regularly (or irregularly) maintained utility line corridor or 2) a Riverine Swamp Forest with a portion that has recently been clear-cut. The decision of whether to break these areas into separate assessment areas should be based on the assessor's best professional judgment. An assessor should guard against being misled by different-aged stands of vegetation within a single wetland type.

If an area of modification within a wetland is small (less than 0.1 acre), separation for this assessment may not be practicable, and these areas can be considered as a whole. On the other hand, if the area of modification is large, or the modification has resulted in a substantial departure from the functional condition of the remainder of the wetland, the assessor may choose to consider these areas separately. A general rule would be that if 10 percent or more of a wetland type is subject to a stressor that changes its wetland character relative to the remainder of the associated wetland type, then separate assessments should be conducted for the two areas.

Another situation that will be encountered is man-made modifications that have unintentionally created wetlands. An example of this situation involves the placement of an underground pipeline parallel to a stream in a floodplain that formerly did not contain wetlands. Introduction of the pipeline and associated back fill can result in a damming effect, slowing surficial drainage or impounding water long enough to result in development of wetlands. As stated above, these wetlands should be identified with the key based on their full range of stable, existing wetland characteristics (vegetation, soils, and hydrology).

### 5.2.3 Assessment Area Identification

"Assessment area" refers to a defined area of wetland which is subject to functional evaluation using NC WAM. Boundaries of the assessment area may be determined by the boundaries of a proposed activity (the project area), wetland type boundaries, the extent of a wetland type with a specific set of characteristics in common, or an upland area. A project area may contain multiple assessment areas, each of which will be evaluated separately using NC WAM.

## 5.3 Completion of the NC WAM Field Assessment Form

Tools needed to complete the NC WAM Field Assessment Form and associated attachments include (but are not limited to) the following.

- Soil auger or sharp-shooter shovel
- Appropriate Munsell soil color chart
- Pocket rod
- Site and watershed mapping
- Global Positioning System (GPS) or other method for determining location
- Camera for recording site conditions and characteristics
- NC WAM dichotomous key to general wetland types
- Knowledge of soil texture-by-feel analysis (Appendix H)
- Knowledge of the latest version of the Natural Resources Conservation Service/National Technical Committee for Hydric Soils (NRCS/NTCHS) "Field Indicators of Hydric Soils in the United States, Guide for Identifying and Delineating Hydric Soils."
- Knowledge of the N.C. Scope and Affect Guide (Appendix G) to analyze the affects of ditches in hydric soils
- Knowledge of the use of NC WAM
- Plant identification manuals such as "Common Wetland Plants of North Carolina (NCDWQ 1997a)

### 5.3.1 Field Assessment Form

The Field Assessment Form is provided with other NC WAM forms at the beginning of the User Manual (current version 3.13, January 12, 2007). Guidance for completion of the Field Assessment Form is provided in Section 4.3. Completion of the Field Assessment Form should be thorough and accurate. It is important that the assessor include notes concerning wetland characteristics, especially any that might not be captured when answering the metrics on the Field Assessment Form. These forms are not only a means to a functional rating, but also a documentation of the condition of the wetland.

Information requested in the box at the beginning of the Field Assessment Form provides space for documentation of stressors affecting the assessment area, regulatory considerations, general site hydrology, and landscape position. The Field Assessment Form requests that the evaluator note evidence of various stressors on an assessment area. This particular information is not directly used in the determination of ratings but helps the assessor consider anthropomorphic impacts to the assessment area. The presence and extent of a stressor should be documented on the Field Assessment Form with consideration for the resulting departure of wetland functions from reference condition for the assessed wetland type.

When evaluating metrics, the assessor should compare the assessed wetland to a reference wetland (if appropriate). A discussion of the intention and use of Field Assessment Form metrics is included in Section 4.3. Familiarization with the watershed of the assessment area

watershed and descriptions of wetland types will facilitate this process. It is essential that the assessor walk the entire assessment area prior to completing the Field Assessment Form.

### 5.3.2 Field Map

The assessor should attach a field map to each completed Field Assessment Form. The field map may be hand drawn or include a refined base map (USGS 7.5-minute topographic quadrangle, county soil survey, aerial photograph, or printed-out map from a web-based geography server or local municipality IMS). The map should provide useful information for the identification of area features for evaluation by regulatory agency personnel and the public.

### 5.3.3 Photographs

Photographs of the assessment area taken while on-site should be attached to the completed Field Assessment Form. Attached photographs should depict typical features of the assessment area.

## 5.4 Generation of Functional Assessment Ratings

### 5.4.1 Data Analysis

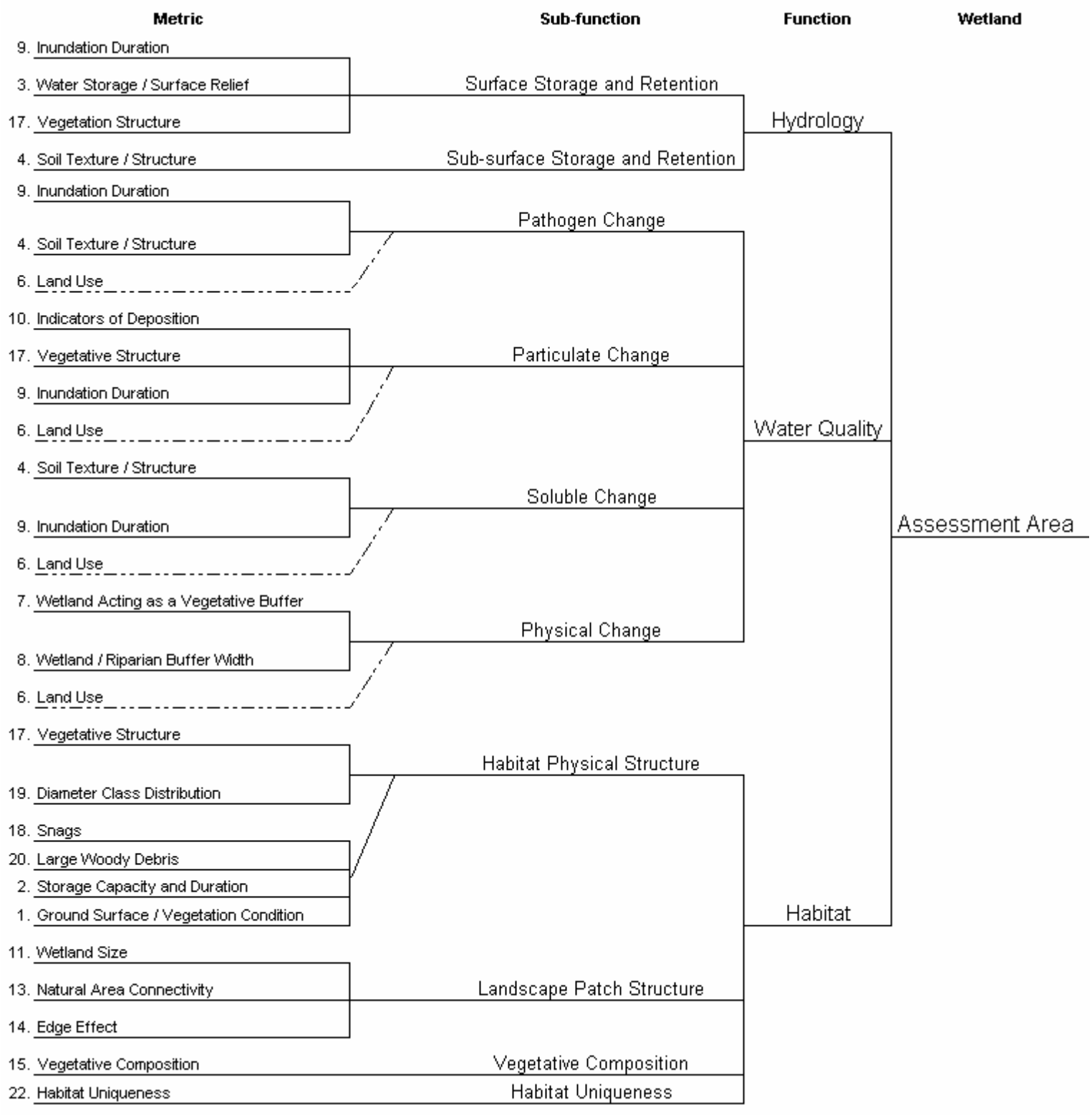
Tools needed for data analysis include the following.

- Completed NC WAM Field Assessment Form and associated attachments
- NC WAM rating calculator computer program to generate of wetland functional ratings

NC WAM utilizes a Boolean logic chain of reasoning to convert the metric evaluation results into functional ratings. The Boolean logic process was developed by the WFAT following extensive discussions regarding the possible interactions of the metrics and sub-functions. These results were re-evaluated at numerous field sites. The Boolean logic has been written into a computer program (NC WAM rating calculator) that generates ratings for wetland metrics, sub-functions, functions, and the over-all wetland. The rating calculator is an Excel macro and is provided on a CD attached to this document.

The Boolean process proceeds by determining descriptors for metrics and then functional ratings for sub-functions, functions, and the assessment area, in sequence. Each level of function subsumes the next, effectively serving as the building blocks for the levels that follow (Table 4). For instance, of the four levels of function, the metric level has the narrowest purview. Singularly, metrics pertain to very specific aspects of the wetland, such as ground surface condition or duration of inundation. Collectively, however, metrics are organized into sub-functions. Combining the descriptors of all metrics within a particular sub-function (through the use of Boolean logic) produces a sub-function rating that offers a broader account of wetland function. Sub-functions themselves are organized into one of three wetland functions: Hydrology, Water Quality, and Habitat. The ratings generated for all sub-functions corresponding to a particular wetland function (such as the Hydrology function) are combined to

Table 4. Relationship of metrics, sub-functions, and functions for generation of wetland functional ratings for a Bottomland Hardwood Forest assessment area.




NOTE:

—— Condition metric

- - - Opportunity metric

// Diagonal lines indicate the potential to modify a sub-function rating

produce a wetland function rating. The individual function ratings provide a still broader account of wetland function than the sub-function ratings. Ultimately, the individual wetland function ratings are combined to produce an over-all wetland rating. The over-all wetland rating is the most comprehensive of the four levels of function – an aggregate of all functional levels considered in NC WAM.

The NC WAM rating calculator provides a screen that approximates the Field Assessment Form. The assessor completes the form within the rating calculator by selecting the proper boxes and option buttons. The program generates functional ratings from the completed form. The assessor can then print a hard copy of the rating results (Wetland Rating Sheet) for the assessed wetland. An example of the Wetland Rating Sheet is provided with forms at the beginning of the User Manual.

### 5.4.2 Final Product

The use of NC WAM is expected to result in the generation of a functional rating for each assessed wetland and the specific component functions and sub-functions of that particular wetland, as well as documentation of field conditions contributing to the ratings. The product resulting from implementation of NC WAM includes, but is not limited to, a completed Field Assessment Form (with assessor notes), a completed Wetland Rating Sheet, a site map, site photographs, and additional notes if appropriate. This product is intended to be utilized by land owners, planners, and state and federal regulatory agency personnel.

The Wetland Rating Sheet (included with the forms at the beginning of the User Manual) is comprised of five sections: general information, red-flag issues, sub-function rating summary, function rating summary, and overall wetland rating. General information at the top of the wetland rating sheet provides limited site information including wetland site name, wetland type, date of assessment, and the assessor's name and organization. Next is a list of five items of interest concerning the assessed wetland. A Yes/No toggle is provided to allow the Wetland Rating Sheet to indicate if one or more of these items is important for the assessment area.

The sub-function rating summary provides ratings for all sub-functions associated with the evaluated wetland type. This summary also indicates if the assessment area has the opportunity for enhanced Water Quality function and how an existing opportunity is expected to modify Water Quality condition ratings. The function rating summary provides the function ratings resulting from a combination of sub-function ratings. This summary also indicates if the assessment area has the opportunity for enhanced Water Quality function and how an existing opportunity is expected to modify the water quality condition rating. Finally, an overall wetland rating is provided, which is a combination of the function ratings for Hydrology, Water Quality, and Habitat.

## 6.0 REFERENCES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# APPENDIX A

## Abbreviations

## APPENDIX A: Abbreviations

| | |
|---|---|
| APES | Albemarle-Pamlico Estuarine Study |
| APNEP | Albemarle-Pamlico National Estuary Program |
| EEP | Ecosystem Enhancement Program |
| EMC | Environmental Management Commission |
| CD | Compact disk |
| CRC | Coastal Resources Commission |
| DBH | Diameter at Breast Height |
| GIS | Geographic Information Systems |
| HGM | Hydrogeomorphic Method |
| IMS | Information Mapping System |
| LIDAR | Light Detection and Ranging |
| NC-CREWS | N.C. Coastal Region Evaluation of Wetland Significance |
| NCDENR | N.C. Department of Environment and Natural Resources |
| NCDOT | N.C. Department of Transportation |
| NCDCM | N.C. Division of Coastal Management |
| NCDMF | N.C. Division of Marine Fisheries |
| NCDWQ | N.C. Division of Water Quality |
| NCNHP | N.C. Natural Heritage Program |
| NC WAM | N.C. Wetland Assessment Method |
| NCWRC | N.C. Wildlife Resources Commission |
| NTCHS | National Technical Committee for Hydric Soils |
| NWI | National Wetlands Inventory |
| ppt | Parts per thousand |
| SWAMP | Strategic Wetland Analysis and Mitigation Plan |
| TM | Thematic Mapper (satellite imagery) |
| TIP | Transportation Improvement Program |
| UWL | Unique Wetland |
| USACE | U.S. Army Corps of Engineers |
| USEPA | U.S. Environmental Protection Agency |
| USFHWA | U.S. Federal Highway Administration |
| USFWS | U.S. Fish and Wildlife Service |
| USGS | U.S. Geological Survey |
| USNMFS | U.S. National Marine Fisheries Service |
| USNRCS | U.S. Natural Resources Conservation Service |
| WFAT | Wetland Functional Assessment Team |
| WRP | Wetlands Restoration Program |

# APPENDIX B

## Cross-reference of Wetland Types

**Appendix B: Cross-reference of wetland types based on NC WAM, N.C. Natural Heritage Program (Schafale and Weakley 1990), N.C. Division of Coastal Management (Sutter 1999), and Hydrogeomorphic Method Classes and Sub-classes (Brinson unpublished)**

| NC WAM [1] | NCNHP [1] | NCDCM [1] | HGM [1] (class/subclass) |
|---|---|---|---|
| Bottomland Hardwood Forest | Coastal Plain Bottomland Hardwoods (Blackwater subtype)<br>Coastal Plain Bottomland Hardwoods (Blackwater subtype)<br>Coastal Plain Levee Forest (Blackwater subtype)<br>Coastal Plain Levee Forest (Brownwater subtype)<br>Piedmont/Mountain Levee Forest<br>Piedmont/Mountain Bottomland Forest<br>Montane Alluvial Forest<br>Piedmont/Low Mountain Alluvial Forest (part) | Bottomland Hardwood Forest | Riverine/Intermittent-Upper Perennial<br>Riverine/Lower Perennial<br>Riverine/Headwater Complex |
| Riverine Swamp Forest | Cypress-Gum Swamp (Blackwater subtype)<br>Cypress-Gum Swamp (Brownwater subtype)<br>Coastal Plain Stream Small Stream Swamp (part)<br>Piedmont/Mountain Swamp Forest<br>Tidal Cypress-Gum Swamp<br>Natural Lake Shoreline | Swamp Forest | Riverine/Lower Perennial<br>Riverine/Headwater Complex<br>Lacustrine Fringe/Semi-permanently Flooded |
| Headwater Wetland | Piedmont Alluvial Forest<br>Coastal Plain Small Stream Swamp (part)<br>Streamhead Atlantic White Cedar Forest<br>Streamhead Pocosin | Headwater Forest | Riverine/Intermittent-Upper Perennial<br>Riverine/Headwater Complex<br>Slope/Mineral Soil |
| Floodplain Pool | Floodplain Pool | Not identified | Riverine/Headwater Wetland<br>Depression/Surface-connected<br>Depression/Isolated Groundwater |
| Pocosin | Low Pocosin<br>High Pocosin<br>Pond Pine Woodland<br>Small Depression Pocosin<br>Bay Forest | Pocosin<br>Pine Flat (part) | Flat/Mineral Soil<br>Flat/Organic Soil<br>Depression/Isolated Groundwater |
| Hardwood Flat | Non-Riverine Wet Hardwood Forest<br>Wet Marl Forest<br>Successional versions of other types | Hardwood Flats | Flat/Mineral Soil |
| Pine Flat | Disturbed versions of the following:<br>Nonriverine Wet Hardwood Forest<br>Nonriverine Swamp Forest<br>Wet Pine Flatwoods<br>Pine Savanna | Pine Flat<br>Managed Pineland | Flat/Mineral Soil |

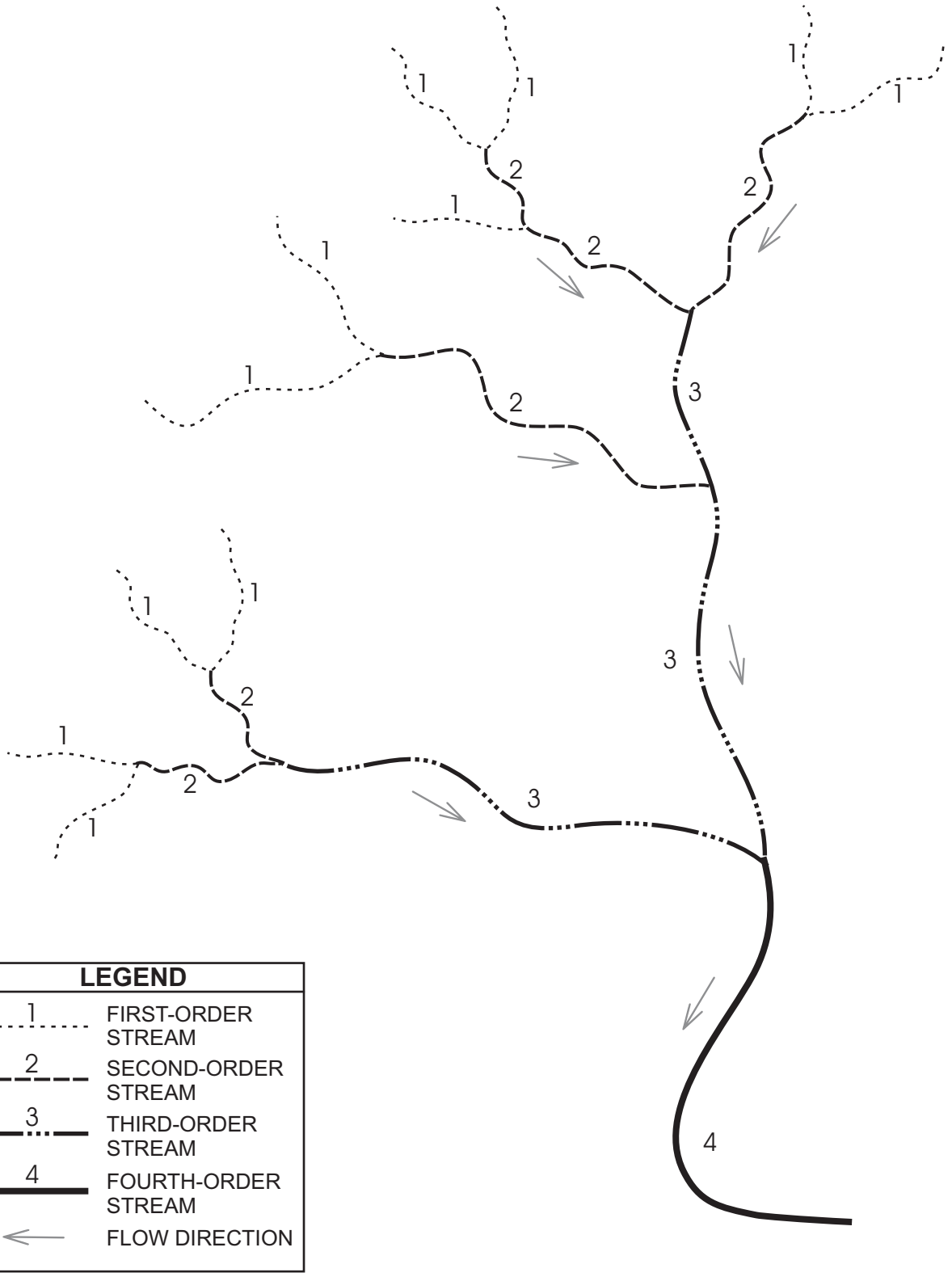
**Appendix B (continued): Cross-reference of wetland types based on NC WAM, NCNHP (Schafale and Weakley 1990), NCDCM (Sutter 1999), and HGM Classes and Sub-classes (Brinson unpublished)**

| NC WAM [1] | NCNHP [1] | NCDCM [1] | HGM [1] (class/subclass) |
|---|---|---|---|
| Pine Savanna | Wet Pine Flatwoods<br>Pine Savannas | Pine Flats | Flat/Mineral Soil |
| Small-Basin Wetland | Vernal Pool<br>Cypress Savanna<br>Upland Depression Swamp Forest<br>Upland Depressional Pond<br>Inner Dune Pond<br>Upland Pool | Not identified<br>possibly Swamp Forest (part)<br>possibly Freshwater Marsh (part) | Depression/Isolated Groundwater<br>Depression/Isolated Precipitation<br>Depression/Human Impounded or Excavated |
| Non-Riverine Swamp Forest | Nonriverine Swamp Forest<br>Peatland Atlantic White Cedar Forest<br>Maritime Swamp Forest<br>Maritime Shrub Swamp | Swamp Forest<br>Maritime Forest | Depression/Isolated Groundwater<br>Depression/Isolated Precipitation<br>Flat/Organic Soil<br>Flat/Mineral Soil |
| Mountain Bog | Southern Appalachian Bog (Northern subtype)<br>Southern Appalachian Bog (Southern subtype)<br>Southern Appalachian Fen<br>Swamp Forest-Bog Complex (Typic subtype)<br>Swamp forest-Bog Complex (Spruce subtype) | Not identified | Depression/Isolated Groundwater<br>Depression/Isolated Precipitation<br>Flat/Organic Soil<br>Flat/Mineral Soil |
| Seep | Low Elevation Seep<br>High Elevation Seep<br>Sandhill Seep<br>Hilllside Seepage Bog | Not identified | Slope/Organic Soil<br>Slope/Mineral Soil |
| Non-tidal Freshwater Marsh | Piedmont/Mountain Semi-permanent Impoundment (part)<br>Coastal Plain Semi-permanent Impoundment (part)<br>Natural Lake Shoreline (part) | Freshwater Marsh | Riverine/Headwater Complex<br>Riverine/Beaver Impounded<br>Riverine/Human Impacted<br>Lacustrine Fringe/Semipermanently Flooded<br>Lacustrine Fringe/Reservoir |
| Tidal Freshwater Marsh | Tidal Freshwater Marsh | Freshwater Marsh | Estuarine Tidal Fringe/Estuarine Lunar<br>Estuarine Tidal Fringe/Estuarine Wind |
| Salt/Brackish Marsh | Salt Marsh<br>Brackish Marsh<br>Salt Flat | Salt/Brackish Marsh | Estuarine Tidal Fringe/Estuarine Lunar<br>Estuarine Tidal Fringe/Estuarine Wind |
| Estuarine Woody Wetland | Salt Shrub<br>Estuarine Fringe Loblolly Pine Forest<br>Tidal Red Cedar Forest | Estuarine Shrub-Scrub<br>Estuarine Forested Wetlands | Estuarine Tidal Fringe/Estuarine Lunar<br>Estuarine Tidal Fringe/Estuarine Wind |

[1] NC Wetland Assessment Method (NC WAM), NC Natural Heritage Program (NCNHP), NC Division of Coastal Management (NCDCM), Hydrogeomorphic Method (HGM)

# APPENDIX C

## Stream Order Schematic


1
1
1
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2
2
1
2
1
1
2
3
1
2
1
1
2
3
1
2
1
3
4
LEGEND
1 FIRST-ORDER STREAM
2 SECOND-ORDER STREAM
3 THIRD-ORDER STREAM
4 FOURTH-ORDER STREAM
FLOW DIRECTION

# APPENDIX D

## Pocosin Soils

## Appendix D: Soil Series Classified as Pocosin Soils for Wetland Type Mapping Generated by the N.C. Division of Coastal Management (NCDCM)

| Series Name | Series Code | County |
|---|---|---|
| Belhaven muck | Bb | Beaufort |
| Belhaven muck | BaA | Camden |
| Belhaven muck | BH | Carteret |
| Belhaven muck | BvA | Dare |
| Belhaven muck | BeA | Gates |
| Belhaven muck | BmA | Hyde |
| Belhaven muck | BH | Pamlico |
| Belhaven muck | Ba | Tyrrell |
| Belhaven muck | Ba | Washington |
| Coxville loam | Co | Columbus |
| Croatan muck | Ct | Beaufort |
| Croatan muck | Cr | Bladen |
| Croatan muck | CT | Brunswick |
| Croatan muck | CT | Carteret |
| Croatan muck | CT | Craven |
| Croatan muck | CT | Cumberland |
| Croatan muck | Ct | Duplin |
| Croatan muck | Ct | Jones |
| Croatan muck | Ct | Onslow |
| Croatan muck | CT | Pamlico |
| Croatan muck | Ct | Pender |
| Croatan muck, freq. flooded | CT | Bladen |
| Dare muck | Da | Beaufort |
| Dare muck | DA | Carteret |
| Dare muck | DA | Craven |
| Dare muck | Da | Currituck |
| Dare muck | DA | Pamlico |
| Murville fine sand | Mu | Columbus |
| Murville fine sand | Mu | Lenoir |
| Murville fine sand | Mu | New Hanover |
| Murville fine sand | Mu | Onslow |
| Murville muck | Mu | Pender |
| Murville mucky fine sand | Mu | Brunswick |
| Murville mucky fine sand | Mu | Duplin |
| Murville mucky loamy sand | Mu | Craven |
| Murville mucky sand | Mu | Carteret |
| Pamlico muck | Pa | Bladen |
| Pamlico muck | Pc | Lenoir |
| Pamlico muck | Pm | New Hanover |
| Pamlico muck | Pm | Sampson |
| Pamlico muck, freq. flooded | PC | Bladen |
| Ponzer muck | Po | Beaufort |
| Ponzer muck | Po | Carteret |
| Ponzer muck | PO | Craven |
| Ponzer muck | Po | Currituck |
| Ponzer muck | PoA | Dare |
| Ponzer muck | PnA | Hyde |
| Ponzer muck | Po | Tyrrell |
| Ponzer muck | Po | Washington |
| Pungo muck | PuA | Camden |
| Pungo muck | PuA | Dare |
| Pungo muck | PuA | Gates |
| Pungo muck | PuA | Hyde |
| Pungo muck | Pu | Tyrrell |
| Pungo muck | Pu | Washington |
| Scuppernong muck | ScA | Hyde |
| Torhunta and Lynn Haven soils | TR | Cumberland |
| Torhunta mucky fine sandy loam | To | Pender |
| Wasda muck | Wd | Beaufort |
| Wasda muck | WdA | Camden |
| Wasda muck | Ws | Carteret |
| Wasda muck | Ws | Currituck |
| Wasda muck | Wd | Pamlico |

# APPENDIX E

## Typical Hydrologic Regimes of North Carolina Marsh Plant Species

## Appendix E: Typical Hydrological Regimes of North Carolina Marsh Plant Species

Plant species typically found in North Carolina marshes separated into categories of non-emergent (N), emergent (E), and aquatic (A) in terms of typical habitat. Some species may be characterized by more than one habitat. This list was taken from Common Wetland Plants of North Carolina, N.C. Division of Water Quality Report # 97-01, August 1997a.

| Scientific Name | Common Name | Wetland Indicator Status* | Habitat |
|---|---|---|---|
| *Alnus serrulata* | Tag Alder | FACW+ | N |
| *Carex* spp. | Sedges | FAC-OBL | E, N |
| *Cephalanthus occidentalis* | Buttonbush | OBL | N |
| *Eleocharis* spp. | Spikerush | FACW-OBL | E, N |
| *Hibiscus moscheutos* | Rose Mallow | OBL | N |
| *Iris virginica* | Blue flag iris | OBL | N |
| *Juncus* spp. | Rush | FACW-OBL | E, N |
| *Lemna* spp. | Common duckweed | OBL | A |
| *Myrica cerifera (Morella cerifera)* | Wax Myrtle | FAC+ | N |
| *Nelumbo lutea* | Water lotus | OBL | A |
| *Nuphar lutea* | Spatterdock, Cow lily | OBL | A |
| *Nymphaea odorata* | Fragrant water lily | OBL | A |
| *Peltandra virginica* | Arrow-arum | OBL | E |
| *Rosa palustris* | Swamp Rose | OBL | N |
| *Sagittaria* spp. | Arrowhead, duck potato | OBL | E |
| *Salix nigra* | Black Willow | OBL | N |
| *Scirpus* spp. | Bulrush | OBL | E, N |
| *Spirodela* spp. | Giant duckweed | OBL | A |
| *Typha* spp. | Cattail | OBL | E |
| *Utricularia* spp. | Bladderwort | OBL | A |
| *Wolffia* spp. | Water meal | OBL | A |

* Wetland Indicator Status (USFWS 1988)

- OBL (Obligate Wetland) – Occur almost always (estimated probability >99%) under natural conditions in wetlands.
- FACW (Facultative Wetland) – Usually occur in wetlands (estimated probability 67%-99%), but occasionally found in non-wetlands.
- FAC (Facultative) – Equally likely to occur in wetlands or non-wetlands (estimated probability 34%-66%).
- The positive (+) or negative (-) sign is used with the indicator category to more specifically define the regional occurrence in wetlands. The positive sign indicates a frequency toward the higher end of the category (more frequently found in wetlands), and a negative sign indicates a frequency toward the lower end of the category (less frequently found in wetlands).

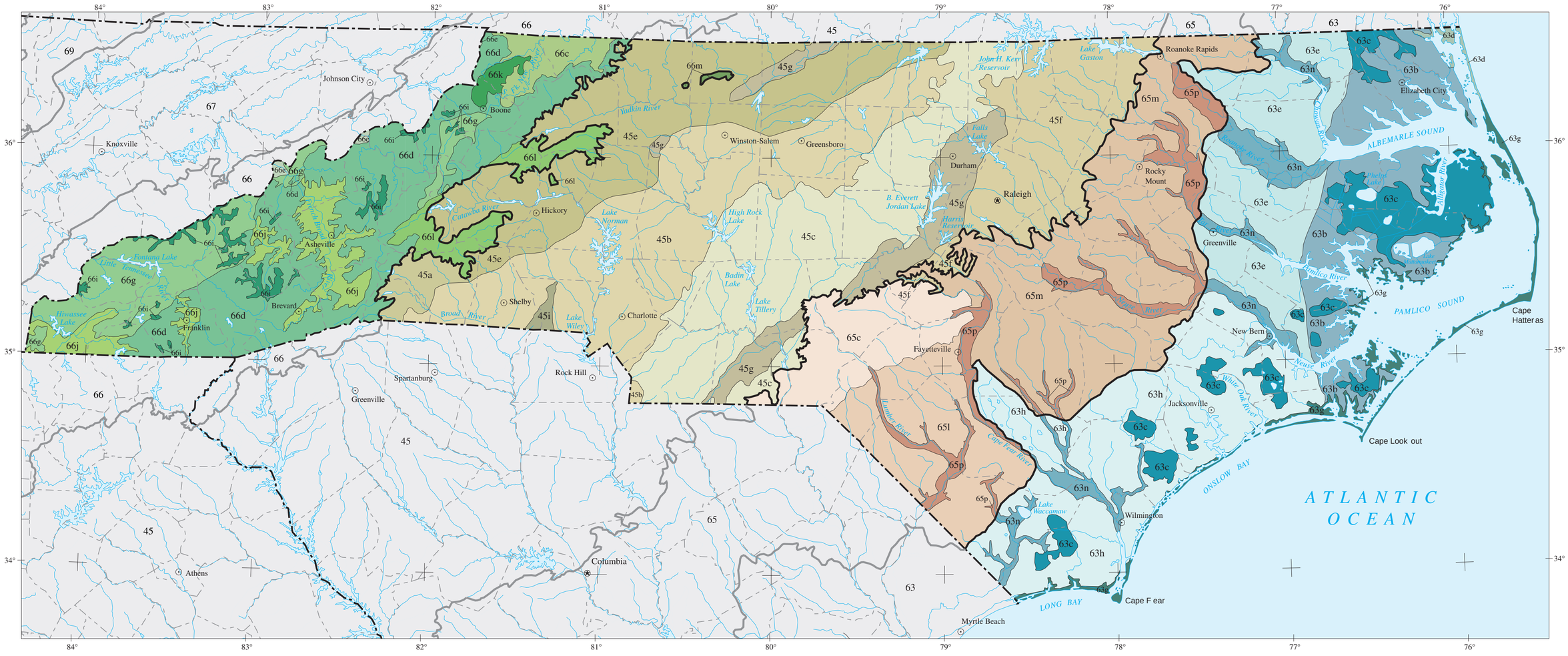
# APPENDIX F

## North Carolina Ecoregions

## Appendix F: North Carolina Ecoregions

This map has been prepared by USEPA and many other state and federal agencies (Griffith et al. 2002). Ecoregions are depicted as either Level III ecoregions (four in the state – Blue Ridge [Mountains], Piedmont, Southeastern Plains [inner Coastal Plain], and Middle Atlantic Coastal Plain [outer Coastal Plain]) or as Level IV ecoregions (27 in North Carolina including such areas as the Triassic Basin, Sandhills and New River Plateau).

# Ecoregions of North Carolina




**45 Piedmont**
- 45a Southern Inner Piedmont
- 45b Southern Outer Piedmont
- 45c Carolina Slate Belt
- 45e Northern Inner Piedmont
- 45f Northern Outer Piedmont
- 45g Triassic Basins
- 45i Kings Mountain

**63 Middle Atlantic Coastal Plain**
- 63b Chesapeake-Pamlico Lowlands and Tidal Marshes
- 63c Nonriverine Swamps and Peatlands
- 63d Virginian Barrier Islands and Coastal Marshes
- 63e Mid-Atlantic Flatwoods
- 63g Carolinian Barrier Islands and Coastal Marshes
- 63h Carolina Flatwoods
- 63n Mid-Atlantic Floodplains and Low Terraces

**65 Southeastern Plains**
- 65c Sand Hills
- 65l Atlantic Southern Loam Plains
- 65m Rolling Coastal Plain
- 65p Southeastern Floodplains and Low Terraces

**66 Blue Ridge**
- 66c New River Plateau
- 66d Southern Crystalline Ridges and Mountains
- 66e Southern Sedimentary Ridges
- 66g Southern Metasedimentary Mountains
- 66i High Mountains
- 66j Broad Basins
- 66k Amphibolite Mountains
- 66l Eastern Blue Ridge Foothills
- 66m Sauratown Mountains

Level III ecoregion — Level IV ecoregion — County boundary — State boundary

SCALE 1:1 500 000

15 10 5 0 30 60 mi

30 20 10 0 60 120 km

Albers Equal Area Projection


PRINCIPAL AUTHORS: Glenn E. Griffith (NRCS), James M. Omernik (USEPA), Jeffrey A. Comstock (Indus Corporation), Michael P. Schafale (NCDENR), W. Henry McNab (USFS), David R. Lenat (NCDENR), and Trish F. MacPherson (NCDENR).

COLLABORATORS AND CONTRIBUTORS: James E. Harrison (USEPA), David L. Penrose (NCDENR), Roy L.Vick, Jr. (NRCS), Gerard McMahon (USGS), Robert Peet (UNC), Chip Smith (NRCS) and Tom Loveland (USGS).



CITING THIS MAP: Griffith, G.E., Omernik, J.M., Comstock, J.A., Schafale, M.P., McNab, W.H., Lenat, D.R., and MacPherson, T.F., 2002, Ecoregions of North Carolina, U.S. Environmental Protection Agency, Corvallis, OR, (map scale 1:1,500,000).


Ecoregions denote areas of general similarity in ecosystems and in the type, quality, and quantity of environmental resources. They are designed to serve as a spatial framework for the research, assessment, management, and monitoring of ecosystems and ecosystem components. Ecoregions are directly applicable to many state agency activities, including the selection of regional stream reference sites, the development of biological criteria and water quality standards, and the establishment of management goals for nonpoint-source pollution. They are also relevant to integrated ecosystem management, an ultimate goal of many federal and state resource management agencies.

The approach used to compile this map of North Carolina is based on the premise that ecological regions are hierarchical and can be identified through the analysis of the spatial patterns and the composition of biotic and abiotic phenomena that affect or reflect differences in ecosystem quality and integrity (Wiken 1986; Omernik 1987, 1995). These phenomena include geology, physiography, vegetation, climate, soils, land use, wildlife, and hydrology. The relative importance of each characteristic varies from one ecological region to another regardless of the hierarchical level. A Roman numeral hierarchical scheme has been adopted for different levels of ecological regions. Level I and Level II divide the North American continent into 15 and 52 regions, respectively (Commission for Environmental Cooperation Working Group 1997). At Level III, the continental United States contains 104 regions (United States Environmental Protection Agency [U.S. EPA] 2000). Level IV is a further subdivision of the Level III ecoregions. Explanations of the methods used to define the U.S. EPA's ecoregions are given in Omernik (1995), Omernik and others (2000), Griffith and others (1994, 1997), and Gallant and others (1989).

The Level III and IV ecoregions were compiled at a scale of 1:250,000 and depict revisions and subdivisions of earlier level III ecoregions that were originally compiled at a smaller scale (U.S. EPA 2000; Omernik 1987). Compilation of this map is part of a collaborative project primarily between the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS), the U.S. EPA National Health and Environmental Effects Research Laboratory (NHEERL), U.S. EPA Region IV, and the North Carolina Department of Environment and Natural Resources. This project is also associated with an interagency effort to develop a common framework of ecological regions (McMahon and others 2001). Regional collaborative projects, such as this one in North Carolina where some agreement can be reached among multiple resource management agencies, are a step in the direction of attaining commonality and consistency in ecoregion frameworks for the entire nation.

Comments regarding the Level III and IV Ecoregions of North Carolina map should be addressed to Glenn Griffith, USDA-NRCS, 200 SW 35th Street, Corvallis, OR 97333, (541) 754-4465, FAX: (541) 754-4716, email: griffith.glenn@epa.gov, or to James Omernik, USGS, 200 SW 35th Street, Corvallis, OR 97333, (541) 754-4458, email: omernik.james@epa.gov.

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NCmapfnl.ai 7/07/2002-gg

# APPENDIX G

## N.C. Scope and Affect Guide (for ditching in hydric soils)

USDA

U' ' States
D nent of
A, ,ture

Natural
Resources
Conservation
Service

1835 Assembly Street
Room 950
Columbia, SC 29201

Subject: Scope & Effect Guide

Date: July 1, 1998

To: Matt Flint, State Biologist

File Code: 190

I am forwarding the completed Scope & Effect Guide for North Carolina hydric soils. This guide provides information about the lateral effect of a drain in a given hydric soil. The Scope & Effect Guide describes the process used and how the values were determined. The procedure used is consistent with NRCS's Engineering Field Handbook, Chapter 19, Hydrology Tools for Wetland Determination and the training course manual for the NEDC class, "Hydrology Tools for Wetland Determination."

Paul Rodrigue, Wetland Science Institute Hydrologist, reviewed the material for technical content. Grady Adkins, South Carolina State Conservation Engineer, and Ben Stuckey, South Carolina State Soil Scientist, were asked for review as well. If you have any questions please contact me at (803)253-3976, voicecom 9031-3976, or email efleming@sc.nrcs.usda.gov.

N. Eric Fleming

N. Eric Fleming
Hydrologist
SE Coastal States Wetland Team

Enclosure

cc: James Williams, Wetlands Coordinator, Columbia

# North Carolina Scope & Effect Guide

This scope and effect guide has been developed in order to provide fast, uniform, and relatively accurate information on the affects of drainage ditches on soil saturation. The material is based upon using soil properties to group soil series into similar categories and using a scope and effect equation for analysis. The scope and effect calculation shows the distance from the ditch to the zone still meeting the wetland hydrology criteria. This distance is referred to as the lateral effect distance, or simply lateral effect. The zone between the ditch and the calculated lateral effect distance does not meet the wetland hydrology criteria (within the limits of this procedure). The calculated distance for each ditch depth and soil grouping is shown in table format, as follows.

The specific soils properties of interest are the hydraulic conductivity (k) and the drainable porosity (f) of each soil series on the North Carolina hydric soils list. The hydraulic conductivity is shown, by layer, for each series in the SOILS 5 data file. The drainable porosity of the soil series is a calculated quantity which is determined by running the MUUF (Map Unit User File) computer program to obtain the drainable water volume at a specific water table depth and dividing by the depth. For the purposes of the Scope & Effect Guide, the drainable porosities of interest are the values calculated for 15 cm (6 in) and 30 cm (12 in) water table depths. The hydraulic conductivities are determined for each soil series by using a diagnostic layer, which is typically the layer from immediately beneath the surface to approximately 30 inches and using the midpoint of the shown range (i.e. 4 inches/hour for the range 2 - 6).

The soil groupings were originally based upon the soil texture of the diagnostic layer. From the original grouping, sample calculations were made and compared to calculations using the average values of the groupings. This allowed the groups to be refined using more specific information (conductivities and drainable porosities). The groups were separated at breaking points between lateral effect distances from sample calculations. The groupings were complicated by the affect of the soil properties on the lateral effect distances. The lateral effect is higher with *higher* conductivities, but the lateral effect is also higher with *lower* drainable porosity. Four groups seemed to emerge from the data.

A) $k < 0.4$ inches/hour and $f \geq 0.1$

B) $0.4 \leq k \leq 1.3$ inches/hour and $f \geq 0.1$
OR
$k < 0.4$ inches/hour and $f < 0.1$

C) $0.4 \leq k \leq 1.3$ inches/hour and $f < 0.1$

D) $k > 1.3$ inches/hour

k = Hydraulic Conductivity and f = Drainable Porosity

These groupings were further subdivided based upon hydrology criteria as defined in the NFSAM (527.4 Wetland Hydrology Criteria) and broken into sandy surface textures and non-sandy surface textures. For the sandy group, the surface texture needed to be S (sand), FS (fine sand), or COS (coarse sand) within 6 inches of the surface.

This category of soil groups was based upon the *saturation within 6 inches of the surface for 14 consecutive days* criterion for the calculations. All other surface textures (including LS, loamy sand, and LFS, loamy fine sand) were included in the category using the *saturation within 12 inches of the surface for 14 consecutive days* criterion. The multiple depths for saturation has created several cases where a given soil series has to be listed in both groupings, and the correct surface texture must be determined in order to use the groupings as designed.

Group soil properties were determined by averaging the individual soil properties within each group. The group properties were then used to run the van Schilfgaarde equation for a series of differing ditch depths to calculated the corresponding lateral effect distances (see EFH Ch. 19, Scope & Effect Equations, and Hydrology Tools for Wetland Determinations course manual). The soil properties were varied by group, the ditch depth was varied by the run within each group, the depth of drawdown was varied by category (sandy surface versus non-sandy) and all the other inputs were held constant. The constant inputs are as follow:

Depth to the Impermeable Layer -- 10 ft
Time -- 14 days
Effective Radius of Drain -- 12 inches

The values used for the group soil properties are as follow:

**Non-Sandy Category**

Group A
k = 0.13 inches/hour, f = 0.120

Group B
k = 0.50 inches/hour, f = 0.088

Group C
k = 1.07 inches/hour, f = 0.036

Group D
k = 8.15 inches/hour, f = 0.079

**Sandy Category**

Group A
No soils in group

Group B
k = 0.77 inches/hour, f = 0.081

Group C
k = 1.30 inches/hour, f = 0.070

Group D
k = 13.83 inches/hour, f = 0.116

## Notes:

1) Site specific information is preferable for delineation purposes.

2) The time factor may be adjusted in the future to account for local growing season information.

3) This procedure assumes surface drainage is sufficient to remove ponding in the area being evaluated. Use Kirkham's equation to evaluate ponding.

4) Site specific scope & effect calculations may be performed using an internet site developed by the NRCS Wetland Science Institute. The address is as follows:

http://www.sedlab.olemiss.edu/java/tools_java.html

5) Use of the internet site requires the user to provide site specific data and to have an understanding of the uses and limitations of scope & effect equations.

6) Drainable porosity values can be calculated using the MUUF computer program. MUUF and the soil input data may be found at the following internet site:

ftp://ftp.wcc.nrcs.usda.gov/water_mgt/muuf/

# Soil Series Groupings

**Non- Sandy Category**

Group A
Dare
Kinkora
Pettigrew
Pungo

Group B
Argent
Armenia
Backbay
Bayboro
Bethera
Bladen
Bohicket
Byars
Cape Fear
Capers
Chastain
Chickahominy
Dorovan
Elkton
Hemphill
Hobonny
Icaria
Leaf
Leaksville
Lenoir
Meggett *
Picture
Ponzer
Roanoke
Roper
Routon
Stockade *
Tawcaw
Trebloc
Una
Wasda
Wilbanks
Worsham

*Sandy and Fine Sandy surface textures included in next category

Group C
Acredale
Axis
Ballahack
Bibb *
Brookman
Chatuge
Chenneby
Chewacla
Chowan
Coxville
Delcomb
Deloss
Fallingston
Fortescue
Galvez
Grantham
Grifton
Hatboro
Hobcaw
Hyde
Kinston
Liddell
Lumbee
McColl
Muckalee
Myatt
Nawney
Nimmo
Othello
Pantego
Paxville
Pelham *
Perquimans
Pocomoke
Portsmouth
Rains *
Toisnot
Tomotley
Tuckerman
Weeksville
Wehadkee
Weston
Yonges

*Sandy and Fine Sandy surface textures included in next category

Group D
Arapahoe
Belhaven
Cartecay
Carteret *
Conaby
Croatan
Currituck
Duckston *
Englehard
Hobucken
Johnston
Lafitte
Leon *
Mascotte*
Masontown
Mattamuskeet
Murville *
Nakina *
Nikwasi
Osier *
Pamlico
Pasquotank
Plummer *
Rutledge *
Scuppernog
Stono
Sylva
Torhunta
Toxaway
Woodington
Wysocking

*Sandy and Fine Sandy surface textures included in next category

## Sandy Category

Group A
no soils

Group B
Bibb
Meggett
Pelham
Stockade

Group C
Olustee
Rains

Group D
Carteret
Duckston
Immokalee
Leon
Lynn Haven
Mascotte
Murville
Nakina
Osier
Plummer
Rutledge

# Lateral Effect Distances

## Non-Sandy Category

Group A

| Ditch Depth (feet) | Lateral Effect (feet) |
|---|---|
| 1 | 15 |
| 2 | 25 |
| 3 | 35 |
| 4 | 40 |
| 5 | 45 |

Group B

| Ditch Depth (feet) | Lateral Effect (feet) |
|---|---|
| 1 | 35 |
| 2 | 65 |
| 3 | 85 |
| 4 | 95 |
| 5 | 105 |

Group C

| Ditch Depth (feet) | Lateral Effect (feet) |
|---|---|
| 1 | 80 |
| 2 | 150 |
| 3 | 195 |
| 4 | 225 |
| 5 | 245 |

Group D

| Ditch Depth (feet) | Lateral Effect (feet) |
|---|---|
| 1 | 155 |
| 2 | 280 |
| 3 | 360 |
| 4 | 415 |
| 5 | 460 |

**Sandy Category**

Group A -- no soil series

Group B

| Ditch Depth (feet) | Lateral Effect (feet) |
|---|---|
| 1 | 90 |
| 2 | 130 |
| 3 | 165 |
| 4 | 185 |
| 5 | 205 |

Group C

| Ditch Depth (feet) | Lateral Effect (feet) |
|---|---|
| 1 | 130 |
| 2 | 185 |
| 3 | 230 |
| 4 | 260 |
| 5 | 285 |

Group D

| Ditch Depth (feet) | Lateral Effect (feet) |
|---|---|
| 1 | 335 |
| 2 | 480 |
| 3 | 585 |
| 4 | 665 |
| 5 | 725 |

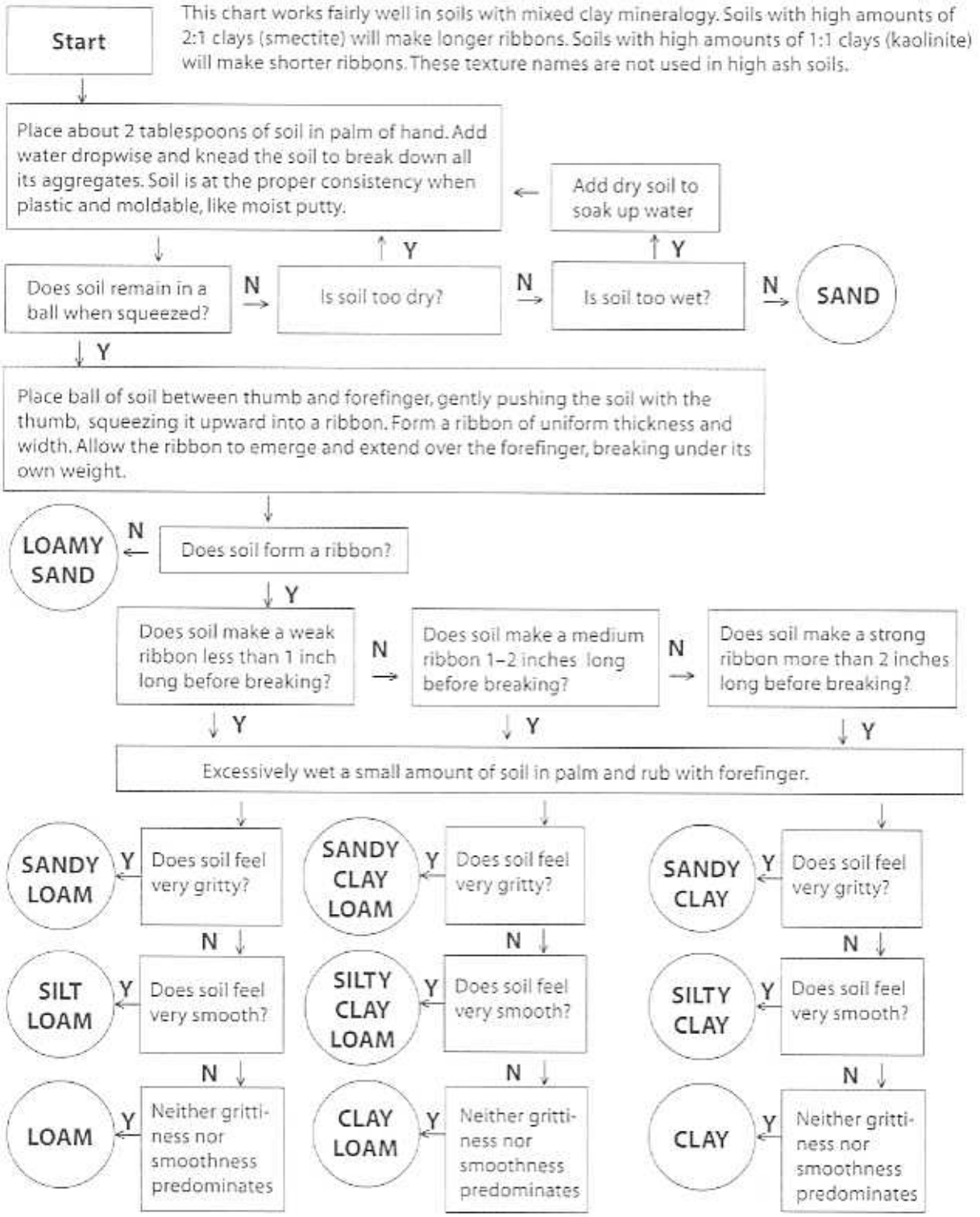
# APPENDIX H

## Soil Texture Decision Chart

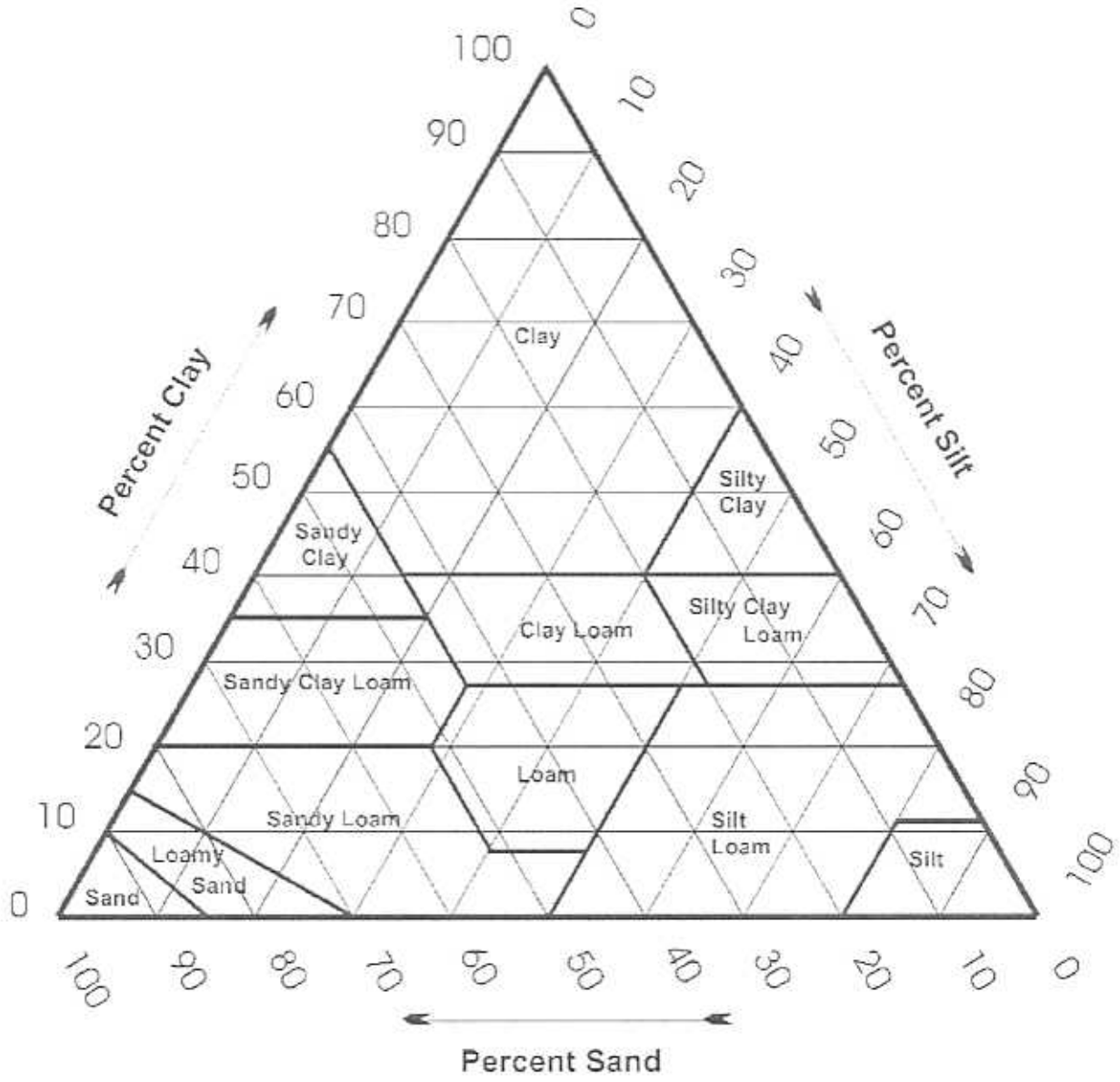
## Appendix H: Soil Texture Decision Chart

This information was obtained on-line at:
http://casfs.ucsc.edu/education/instruction/tofg/download/unit_2.1b_soil_physical.pdf

# Soil Texture Decision Chart



## Soil Texture Triangle



# APPENDIX I

## North Carolina Exotic Plants

## Appendix I: North Carolina Exotic Plants

This table identifies exotic, invasive plant species that have been identified by state, federal, or regional entities as indicated by an "X" in the three right columns. Some of the species are regulated by law.

- Plants listed under "N.C. Law" fall under North Carolina Department of Agriculture Noxious Weed Regulations (02 NCAC 48A. 1700). Sale, distribution, and conveyance of these plants are restricted within North Carolina.
- Plants listed under "U.S. Law" fall under the Federal Noxious Weed Regulations (7CFR360), compiled by the Animal and Plant Health Inspection Service (APHIS) of the United States Department of Agriculture. Movement or dissemination of the included species is restricted within the United States.
- Plants listed under "USFS Policy" are identified in the Southeast Exotic Pest Plant Council's Regional Invasive Exotic Plant Species List, available at: http://www.se-eppc.org/fslist.cfm. These plants are not necessarily regulated, but have been identified by public and private land managers as exotic and invasive species that pose management concerns.
- The entire list can be viewed at http://www.invasive.org/seweeds.cfm.

| Scientific Name | Common Name | N.C. Law | U.S. Law | USFS Policy |
|---|---|---|---|---|
| **Vines** | | | | |
| *Ampelopsis brevipedunculata* (Maxim.) Trautv. | Amur peppervine | | | X |
| *Celastrus orbiculatus* Thunb. | oriental bittersweet | X | | X |
| *Coronilla varia* L. | purple crownvetch | | | X |
| *Cuscuta* spp. L. | dodder | X | X | |
| *Dioscorea alata* L. | water yam | | | X |
| *Dioscorea bulbifera* L. | air yam | | | X |
| *Dioscorea oppositifolia* L. | Chinese yam | | | X |
| *Euonymus fortunei* (Turcz.) Hand.-Maz. | winter creeper | | | X |
| *Hedera helix* L. | English ivy | | | X |
| *Ipomoea aquatica* Forsskal | swamp morning-glory | X | X | |
| *Lonicera japonica* Thunb. | Japanese honeysuckle | | | X |
| *Lygodium japonicum* (Thunb. ex Murr.) Sw. | Japanese climbing fern | | | X |
| *Mikania cordata* (Burm. f.) B.L. Robins. | heartleaf hempvine | X | X | |
| *Mikania micrantha* Kunth | bittervine | X | X | |
| *Polygonum perfoliatum* L. | mile-a-minute weed | X | | X |
| *Pueraria montana* (Lour.) Merr. | kudzu | | | X |
| *Tribulus terrestris* L. | puncturevine | X | | |
| *Wisteria floribunda* (Willd.) DC. | Japanese wisteria | | | X |
| *Wisteria sinensis* (Sims) DC. | Chinese wisteria | | | X |
| **Shrubs or Subshrubs** | | | | |
| *Berberis thunbergii* DC. | Japanese barberry | | | X |

| Scientific Name | Common Name | N.C. Law | U.S. Law | USFS Policy |
|---|---|---|---|---|
| *Elaeagnus pungens* Thunb. | thorny olive | | | X |
| *Elaeagnus umbellata* Thunb. | autumn olive | | | X |
| *Lespedeza cuneata* (Dum.-Cours.) G. Don | Chinese lespedeza | | | X |
| *Ligustrum japonicum* Thunb. | Japanese privet | | | X |
| *Ligustrum lucidum* Ait. f. | glossy privet | | | X |
| *Ligustrum sinense* Lour. | Chinese privet | | | X |
| *Ligustrum vulgare* L. | European privet | | | X |
| *Lonicera fragrantissima* Lindl. & Paxton | sweet breath of spring | | | X |
| *Lonicera maackii* (Rupr.) Herder | Amur honeysuckle | | | X |
| *Lonicera morrowii* Gray | Morrow's honeysuckle | | | X |
| *Lonicera tatarica* L. | Tatarian honeysuckle | | | X |
| *Ludwigia uruguayensis Camb.)* Hara | Uruguayan primrose-willow | X | | |
| *Lycium ferrocissimum* Miers | African boxthorn | X | X | |
| *Melastoma malabathricum* L. | Malabar melastome | X | X | |
| *Mimosa diplotricha* C. Wright ex Sauvalle | giant sensitive plant | X | X | |
| *Mimosa pigra* L. | catclaw mimosa | X | X | X |
| *Nandina domestica* Thunb. | sacred bamboo | | | X |
| *Polygonum cuspidatum* Sieb. & Zucc. | Japanese knotweed | | | X |
| *Rosa multiflora* Thunb. ex Murr. | multiflora rose | | | X |
| *Rubus fruticosus* L. | shrubby blackberry | X | X | |
| *Rubus moluccanus* L. | wild blackberry | X | X | |
| *Spiraea japonica* L. f. | Japanese meadowsweet | | | X |
| **Parasitic and Epiphytic Plants** | | | | |
| *Orobanche minor* Smith | small broomrape | X | X | |
| *Orobanche ramosa* L. | broomrape | X | X | |
| *Orobanche spp.* L. | broomrape | | X | |
| *Striga asiatica* (L.) Kuntze | Asiatic witchweed | X | X | |
| *Striga gesnerioides* (Willd.) Vatke | cowpea witchweed | X | X | |
| *Striga* spp. Lour. | witchweed | X | X | |
| **Hardwood Trees** | | | | |
| *Ailanthus altissima* (P. Mill.) Swingle | tree of heaven | | | X |
| *Albizia julibrissin* Durazz. | mimosa | | | X |
| *Elaeagnus angustifolia* L. | Russian olive | | | X |
| *Melaleuca quinquenervia* (Cav.) Blake | melaleuca | X | X | |
| *Prosopis* spp. L. | mesquite | X | X | |
| *Triadica sebifera* (L.) Small | tallow tree | | | X |
| **Grass or Grasslike Plants** | | | | |
| *Arthraxon hispidus* (Thunb.) Makino | small carpgrass | | | X |
| *Avena sterilis* L. | animated oat | X | X | |
| *Bromus inermis* Leyss. | smooth brome | | | X |

| Scientific Name | Common Name | N.C. Law | U.S. Law | USFS Policy |
|---|---|---|---|---|
| *Chrysopogon aciculatus* (Retz.) Trin. | golden false beardgrass | X | X | |
| *Digitaria abyssinica* (A. Rich) Stapf | African couchgrass | X | X | |
| *Digitaria velutina* (Forsk.) Beauv. | velvet fingergrass | X | X | |
| *Eragrostis curvula* (Schrad.) Nees | weeping lovegrass | | | X |
| *Imperata brasiliensis* Trinius | Brazilian satintail | X | X | |
| *Imperata cylindrica* (L.) Beauv. | cogongrass | X | X | X |
| *Ischaemum rugosum* Salisbury | murainagrass | X | X | |
| *Leptochloa chinensis* (L.) Nees | Asian sprangletop | X | X | |
| *Lolium arundinaceum* (Schreb.) S.J. Darbyshire | tall fescue | | | X |
| *Microstegium vimineum* (Trin.) A. Camus | Nepalese browntop | | | X |
| *Miscanthus sinensis* Anderss. | Chinese silvergrass | | | X |
| *Nassella trichotoma* Hackel ex Arech. | serrated tussock grass | X | X | |
| *Oryza longistaminata* A. Chev. & Roehr. | longstamen rice | X | X | |
| *Oryza punctata* Kotzchy ex Steud. | red rice | X | X | |
| *Oryza rufipogon* Griffiths | brown-beard rice, Wild red rice | X | X | |
| *Paspalum scrobiculatum* L. | kodomillet | X | X | |
| *Pennisetum clandestinum* Hochst. ex Chiov. | kikuyugrass | X | X | |
| *Pennisetum macrourum* Trinius | African feathergrass | X | X | |
| *Pennisetum pedicellatum* Trinius | Kyasuma grass | | X | |
| *Pennisetum polystachyon* (L.) Schultes | mission grass | X | X | |
| *Phleum pratense* L. | timothy | X | | |
| *Rottboellia cochinchinensis* (Lour.) W.D. Clayton | itchgrass | X | X | |
| *Saccharum spontaneum* L. | wild sugarcane | X | X | |
| *Setaria pumila pallidifusca* (Schumacher) B.K. Simon | yellow bristlegrass | X | X | |
| *Sorghum halepense* (L.) Pers. | Johnsongrass | | | X |
| *Urochloa panicoides* Beauvois | liverseed grass | X | X | |
| **Forbs / Herbs** | | | | |
| *Aeginetia spp.* L. | Aeginetia, Bunga | X | X | |
| *Ageratina adenophora* (Spreng.) King & H.E. Robins. | crofton weed | X | X | |
| *Alectra* spp. Thunb. | alectra | X | X | |
| *Alliaria petiolata* (Bieb.) Cavara & Grande | garlic mustard | | | X |
| *Allium vineale* L. | wild garlic | | | X |
| *Asphodelus fistulosus* L. | onionweed | X | X | |
| *Carduus acanthoides* L. | spiny plumeless thistle | X | | |
| *Carduus nutans* L. | musk thistle | X | | X |
| *Carthamus oxyacantha* Bieb. | wild safflower | X | X | |
| *Cirsium arvense* (L.) Scop. | Canada thistle | X | | X |

| Scientific Name | Common Name | N.C. Law | U.S. Law | USFS Policy |
|---|---|---|---|---|
| *Cirsium vulgare* (Savi) Ten. | bull thistle | | | X |
| *Commelina benghalensis* L. | tropical spiderwort | X | X | |
| *Crassula helmsii* A. Berger | swamp stonecrop | X | | |
| *Crupina vulgaris* Cass. | common crupina | X | X | |
| *Drymaria arenarioides* Humboldt & Bonpland | sandwort drymary | X | X | |
| *Emex australis* Steinhall | three-cornered jack | X | X | |
| *Emex spinosa* (L.) Campdera | devil's thorn | X | X | |
| *Galega officinalis* L. | goat's rue | X | X | |
| *Heracleum mantegazzianum* Sommier & Levier | giant hogweed | X | X | |
| *Homeria* spp. N/A | cape tulip | X | X | |
| *Hygrophila polysperma* (Roxb.) T. Anders. | miramar weed | X | X | |
| *Kummerowia striata (Thunb.) Schindl.* | Japanese clover | | | X |
| *Limnophila sessiliflora* (Vahl) Blume | Asian marshweed | X | X | |
| *Lythrum salicaria* L. | purple loosestrife | X | | X |
| *Monochoria hastata* (L.) Solms | arrowleaf false pickerelweed | X | X | |
| *Monochoria vaginalis* (Burm. f.) K. Presl ex Kunth | heartshape false pickerelweed | X | X | |
| *Polygonum caespitosum* Blume | oriental ladysthumb | | | X |
| *Rorippa sylvestris* (L.) Bess. | creeping yellowcress | X | | |
| *Salsola vermiculata* L. | shrubby Russian thistle | X | X | |
| *Solanum torvum* Swartz | turkey berry | X | X | |
| *Solanum viarum* Dunal | tropical soda apple | X | X | X |
| *Spermacoce alata* Aublet | winged false buttonweed | X | X | |
| *Stachys floridana* Shuttlw. ex Benth. | Florida hedgenettle | X | | |
| *Tridax procumbens* L. | coatbuttons | X | X | |
| *Verbena brasiliensis* Vell. | Brazilian vervain | | | X |
| **Cactus** | | | | |
| *Opuntia aurantiaca* Lindley | Jointed prickly pear, Tiger pear | X | X | |
| **Aquatic** | | | | |
| *Alternanthera philoxeroides* (Mart.) Griseb. | alligatorweed | | | X |
| *Alternanthera sessilis* (L.) R. Br. ex DC. | sessile joyweed | X | X | |
| *Azolla pinnata* R. Brown | feathered mosquitofern | X | X | |
| *Caulerpa taxifolia* (Vahl) C. Agardth | Mediterranean clone of caulerpa | X | X | |
| *Egeria densa* Planch. | Brazilian waterweed | | | X |
| *Eichhornia azurea* (Swartz) Kunth | anchored water hyacinth | X | X | |
| *Eichhornia crassipes* (Mart.) Solms | common water hyacinth | X | | X |
| *Hydrilla verticillata* (L. f.) Royle | hydrilla | X | X | X |
| *Lagarosiphon major* (Ridley) Moss | oxygen weed | X | X | |

| Scientific Name | Common Name | N.C. Law | U.S. Law | USFS Policy |
|---|---|---|---|---|
| *Myriophyllum spicatum* L. | Eurasian watermilfoil | X | | X |
| *Ottelia alismoides* (L.) Pers. | duck-lettuce | X | X | |
| *Pistia stratiotes* L. | water lettuce | | | X |
| *Sagittaria sagittifolia* L. | Hawaii arrowhead | X | X | |
| *Salvinia auriculata* Aublet | eared water-moss | X | X | |
| *Salvinia biloba* Raddi | giant salvinia | X | X | |
| *Salvinia herzogii* de la Sota | giant salvinia | X | X | |
| *Salvinia molesta* D. S. Mitchell | giant salvinia | X | X | X |
| *Solanum tampicense* Dunal | wetland nightshade | X | X | |
| *Sparganium erectum* L. | exotic bur-reed | X | X | |
| *Trapa natans* L. | water chestnut | X | | |

# APPENDIX J

## Tool Box User Guide

## Appendix J: Tool Box User Guide

### J-1.0 Introduction

The NC WAM Tool Box will be maintained and updated by EcoScience Corporation until the User Manual is finalized, at which time Tool Box responsibility will convert to a natural resource agency (likely the N.C. Division of Water Quality [NCDWQ]). This resource has been developed with the intention that it will be a publicly accessible and evolving product which will increase in content and value as assessed wetlands continue to be added.

The NC WAM Tool Box provides a reference set of wetlands intended to help familiarize evaluators with the NC-WAM methodology and aid in the identification and evaluation of wetlands not contained in the database. Each wetland in the Tool Box has been evaluated by the WFAT and is accompanied by site specific information (aerial photography, topographic maps, and site photographs) as well as WFAT-completed field assessment forms. While not comprehensive, the wetland-specific information is intended to aid assessors in the evaluation of other wetlands by providing a basis of comparison to WFAT-scored wetlands. For instance, an examination of the Bottomland Hardwood Forest wetlands contained in the Tool Box may prove useful for identifying and assessing similar systems encountered by assessors. Only the ArcView 9.x version of the Tool Box will be updated. The other versions are intended for the user to learn the Tool Box and understand its benefit.

### J-2.0 Installation

The Tool Box consists of an ArcView project as well as a collection of images and text files. ArcView must be installed on your computer to use the Tool Box.

The Tool Box CD-ROM contains three versions of the Tool Box ArcView project: ncwam_tool box_av3, ncwam_tool box_av8, and ncwam_tool box_av9. Each project is designed to be used with a different version of ArcView. For example, ncwam_tool box_av3 was constructed for use with ArcView 3.x, ncwam_tool box_av8 was constructed for use with ArcView 8.x, and ncwam_tool box_av9 was constructed for use with ArcView 9.x. To insure proper functioning of the Tool Box, use the ArcView project that corresponds to the version of ArcView installed on your computer.

The NC WAM Tool Box ArcView project may be run from either the Tool Box CD-ROM or a local hard drive. Running the Tool Box from the CD-ROM simply involves double-clicking the appropriate ArcView project (e.g., ncwam_tool box_av3.apr for ArcView 3.x users, and so on). To run the Tool Box from a local hard drive, copy the appropriate ArcView project along with the FieldSheets, JPEGS, and WAM Shapefiles folders to a local directory. Running the Tool Box from a local hard drive will increase the Tool Box operating speed. A note of caution: when

copying the above components to your local hard drive take care to maintain the directory structure present on the Tool Box CD-ROM. The ArcView project will not function properly if the directory structure is altered. An example of a correct installation would be to copy the appropriate ArcView project plus the FieldSheets, JPEGS and WAMShaperfile folders to the directory C:\Projects\Wetlands (Figure J-1).

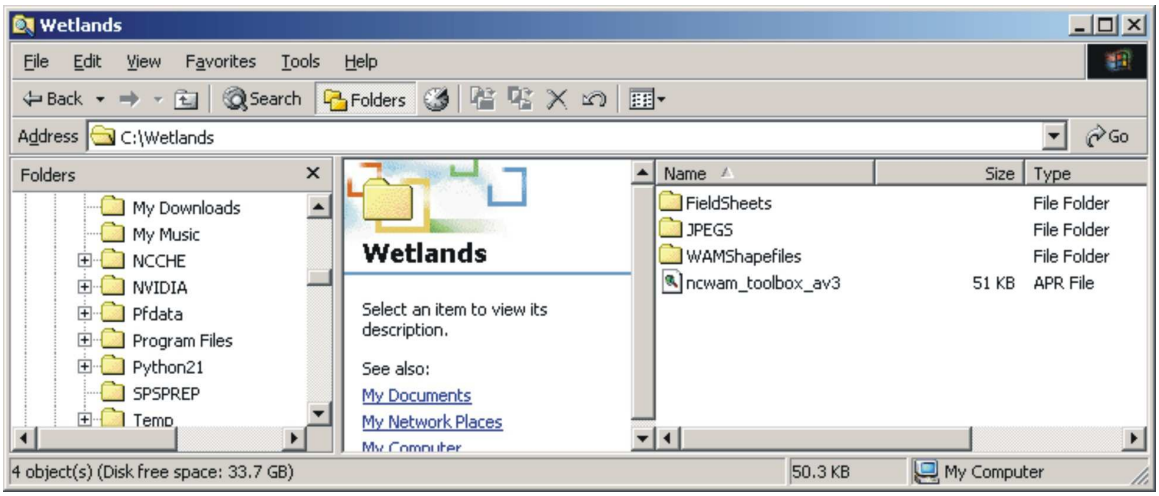



Figure J-1. A correct local installation of the Tool Box on a computer with ArcView 3.x

The ArcView 3.x version of the Tool Box requires the JPEG (JFIF) Image Support extension to function. If this extension is not installed on your computer, copy the JFIF.avx file located in the Extensions folder on the Tool Box CD-ROM to the \ESRI\AV_GIS30\ARCVIEW\EXT32 directory. This step is not necessary for users of the ArcView 8.x and 9.x versions of the Tool Box.

## J-3.0 Operation

### J-3.1 ArcView 3.x

Open the Tool Box ArcView 3.x project by double-clicking the ncwam_tool box_av3.apr file. The key feature of the Tool Box is that each of the wetland sites are linked to an aerial photograph, topographic map, site photographs, and/or WFAT-scored, wetland assessment form; although, the supplementary information available for a given wetland may vary.

After the project has opened, make sure the JPEG (JFIF) Image Support extension is activated. Select the Extensions option from the File menu (File|Extensions). Scroll down the list of available extensions. The JPEG (JFIF) Image Support extension is activated if a checkmark appears in the box adjacent the extension name. If the extension is not activated, do so by clicking on the adjacent box. If the JPEG (JFIF) Image Support extension is not present in the

list of extensions, the extension will need to be installed on your local hard drive (see Section J-2.0).

The wetland-specific information is viewed using the Hot Link tool. Activate the Hot Link tool by clicking the lightning bolt button in the toolbar (Figure J-2). The pointer becomes a lightning bolt. With the Wetland Sites theme as the active theme, click on any of the wetland sites (wetlands sites are depicted as pink squares). The wetland-specific information available for the chosen site appears in cascading windows in the upper left-hand corner of the ArcView project window. Rearrange and/or resize the windows as necessary to view the wetland-specific information (Figure J-3). Close the wetland-specific information by clicking the x button in the upper right-hand corner of the windows.


Figure J-2. Activate the Hot Link tool by clicking the lightning bolt button (denoted by the arrow).

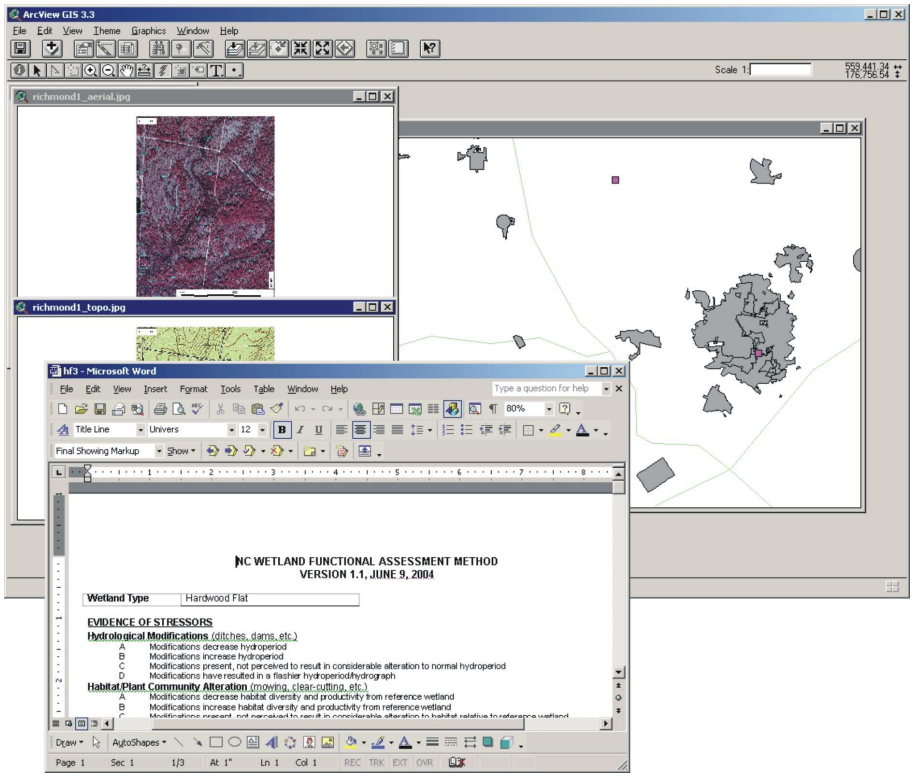



Figure J-3. Wetland site-specific information is presented when clicking on a Hot Link tool.

### J-3.2 ArcView 8.x and 9.x

Both the Tool Box ArcView 8.x and 9.x projects are opened by double-clicking the corresponding .mxd file: ncwam_tool box_av8.mxd for the ArcView 8.x project and ncwam_tool box_av9.mxd for the ArcView 9.x project. The key feature of the Tool Box is that each of the wetland sites is linked to an aerial photograph, topographic map, site photographs, and/or WFAT-completed field assessment form; although, the supplementary information available for a given wetland may vary.

Wetland-specific information is viewed using the Hyperlink tool. Activate the Hyperlink tool by clicking the lightning bolt button in the toolbar (Figure J-4). The pointer becomes a lightning bolt. If the Hyperlink tool is not present in the toolbar, use the Customize dialog to add the Hyperlink tool. To do so, first access the Customize dialog by clicking the Customize option in the Tools menu (Tools|Customize). Next, click the Commands tab. In the left window, scroll down and click the Selection option. The Selection tools appear in the right window (Figure J-5). Click the Hyperlink icon (the lightning bolt) and drag it to the toolbar in the ArcMap window. Now, select the Hyperlink tool.

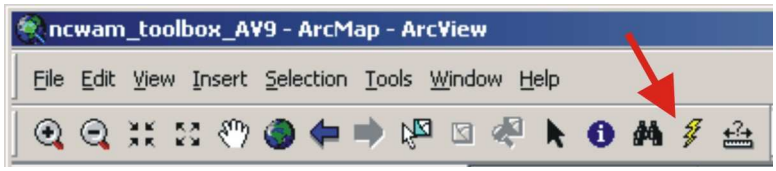



Figure J-4. Activate the Hyperlink tool by clicking the lightning bolt (denoted by the arrow).

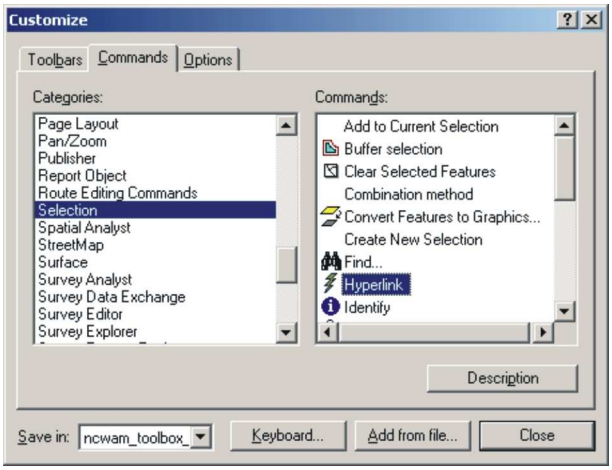



Figure J-5. The Hyperlink tool is accessed from the Customize dialog.

When the Hyperlink tool is activated, blue dots appear in the center of the pink squares depicting the wetland sites. Blue dots indicate the wetlands that have hyperlinked information associated with them. Click on any of the wetland sites. The Select Document dialog appears displaying the supplementary information available for the wetland (Figure J-6). Click on the desired document and then click the OK button. The selected document appears. Rearrange and/or resize the document window as appropriate. Close the document by clicking the x button in the upper right-hand corner of document window. Repeat the process to view additional wetland information.

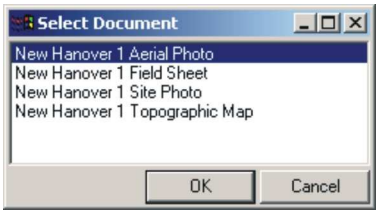



Figure J-6. The Select Document dialog presents the wetland-specific information.

Depending on the scale at which the ArcView project is viewed, the marker depicting the location of one wetland may overlay the marker of a nearby wetland. This scenario most often occurs when the map is viewed at a small scale (i.e., zoomed out). In some instances, clicking on overlapping wetlands with the Hyperlink tool prompts the Hyperlink dialog to appear, not the Select Document dialog (Figure J-7); the Hyperlink dialog in effect preempts the Select Document dialog discussed above. The Hyperlink dialog displays the selected sites. At this point, select a single site from the Hyperlink dialog and click the Jump button. The Select Document dialog appears displaying the supplementary information for the chosen wetland. Now, select the desired document as detailed above. This situation can be avoided, however, by zooming in the map view to the point that the wetland markers are no longer overlapping.

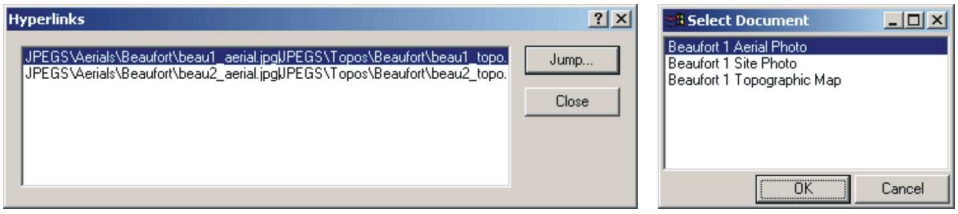



Figure J-7. Select the desired wetland site from the Hyperlink dialog to prompt the Select Document dialog.

# APPENDIX K

## NC WAM Rating Calculator User Guide

# Appendix K: NC WAM Rating Calculator User Guide

## K-1.0 Introduction

Wetland functional ratings are generated by processing wetland assessment data collected on the NC WAM Wetland Assessment Form through a Boolean logic chain of reasoning. Each of the 16 general wetland types has its own unique and rather extensive Boolean logic chain. While it is possible to generate functional ratings by manually processing wetland assessment data, the effort would be time consuming and, due to the complicated nature of the Boolean logic, potentially prone to miscalculation. To reduce processing time and ensure proper processing of assessment data, the Wetland Functional Assessment Team (WFAT) directed the development of the NC WAM Rating Calculator.

The NC WAM Rating Calculator consists of a pair of Microsoft Excel worksheets designed to resemble the NC WAM Wetland Assessment Form and the NC WAM Wetland Rating Sheet. The purpose of the Rating Calculator is to automate the wetland rating process. Wetland assessment data collected in the field is input into the Rating Calculator. The computer program imbedded within the Rating Calculator passes the assessment data through the wetland-specific Boolean logic chain to produce functional ratings. Instructions for use of the Rating Calculator follow.

## K-2.0 Rating Calculator Instructions

### K-2.1 Opening the Rating Calculator

The Rating Calculator was constructed within Microsoft Excel and contains macros (computer programming code). Excel has a macro security feature that regulates the use of macros within Excel itself. Prior to opening the Rating Calculator, Excel's macro security needs to be set to allow the operation macros. To set Excel's macro security, start the Excel program and access the Macro Security dialog from the Tools menu (Tools|Macros|Security). Select the Medium level of security from the Security Level tab and click OK (Figure K-1). Close the Excel program.

The Rating Calculator is opened like a typical Excel file – by either double-clicking the Rating Calculator file or by using the Open function available in Excel's File menu (File|Open). Open the Rating Calculator using one of the described methods. Upon opening the Rating Calculator, a dialog appears indicating that the file contains macros. Click Enable Macros to continue opening the file. The Rating Calculator may take a few moments to initialize. The initialization procedures are complete and the form ready to operate when the mouse cursor is no longer an hourglass.

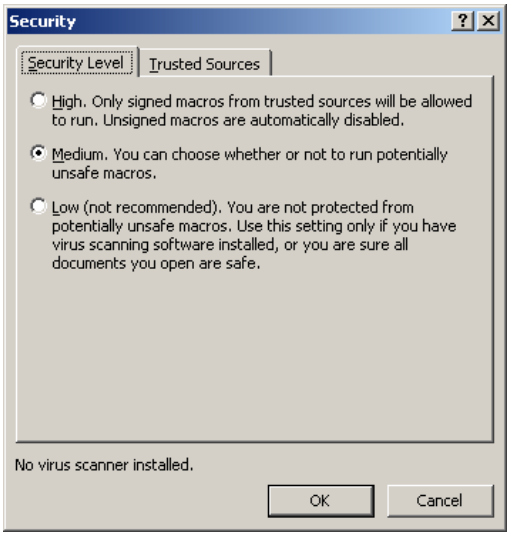



Figure K-1. Set the Excel macro Security Level to Medium.

### K-2.2 Rating Calculator Contents

The Rating Calculator has two worksheets: the Form worksheet and the Results worksheet. The Form worksheet is a replication of the NC WAM Wetland Assessment Form and the Results worksheet that of the NC WAM Wetland Rating Sheet. Wetland assessment data collected in the field are transcribed from the NC WAM Wetland Assessment Form onto the Form worksheet. The resulting functional ratings are presented on the Results worksheet.

Use the Form and Results tabs located in the bottom left-hand corner of the Rating Calculator screen to toggle between the two worksheets (Figure K-2). Click the Form tab to display the Form worksheet and the Results tab to display the Results worksheet. The operation of both worksheets is described below.

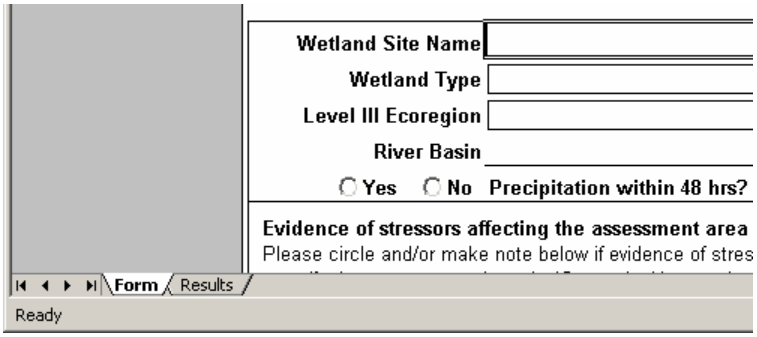



Figure K-2. Use the Form and Results tabs to toggle between the respective worksheets.

### K-2.2.1 Form Worksheet

The Form worksheet is displayed when the Rating Calculator opens. The Form worksheet contains all components of the NC WAM Wetland Assessment Form; each metric as well as the general wetland information and notes sections are represented. Several different types of user interfaces are used for inputting the wetland assessment data: text fields, combo boxes, option buttons, and checkboxes.

**Text fields** provide space for information to be typed in via the keyboard. General wetland information, such as the wetland site name, assessor name, stressor notes, and wetland notes are input into text fields (Figure K-3). Information is input into text fields by clicking on a specific text field with the mouse and then typing with the keyboard.

Two **combo boxes** are used in the general wetland information section of the Form worksheet to specify the assessed wetland type and ecoregion of occurrence. The Wetland Type combo box lists the 16 general wetland types in NC WAM (Figure K-3). The Level III Ecoregion combo box lists the four level III ecoregions that occur in North Carolina, plus the Sandhills level IV ecoregion (Figure K-3). The combo boxes are used by clicking the arrow on the right side of the combo box and selecting the appropriate entry from the dropdown list. Both the wetland type and ecoregion are required information for calculating wetland functional ratings.

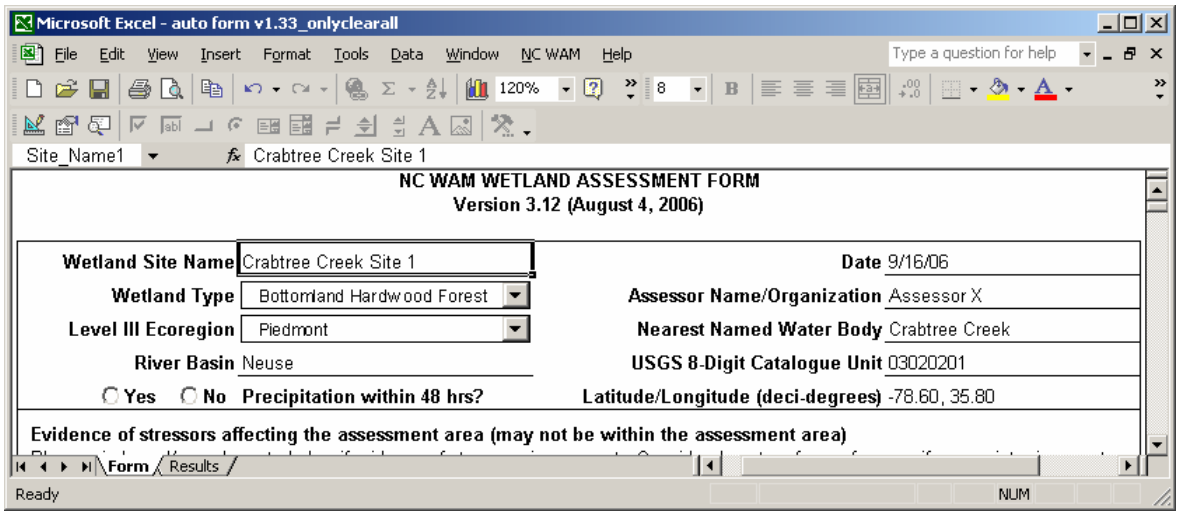



Figure K-3. Text field and combo box items on the Form worksheet.

Option buttons and checkboxes are used throughout the Form worksheet to record the selection of metric descriptors, regulatory considerations, and stream types, among other items (Figure K-4). Option buttons are used to select mutually exclusive items. Consider Metric 9 (Inundation Duration) for example (see NC WAM Field Assessment Form provided at the beginning of the User Manual, current version 3.13, January 12, 2007). The three descriptors of metric number 9 are mutually exclusive; the inundation duration condition denoted by descriptor "A" can only occur absent the conditions described by descriptors "B" and "C," and vice versa. On the other hand, checkboxes are used for inclusive items. For instance, the land use conditions described

in metric number 6 (Land Use) are not necessarily exclusive of each other; multiple land use conditions may occur within the same watershed. The same is true for the regulatory considerations in the general wetland information section. Using checkboxes for inclusive scenarios, as is the case for metric number 6, allows multiple items to be selected at once.

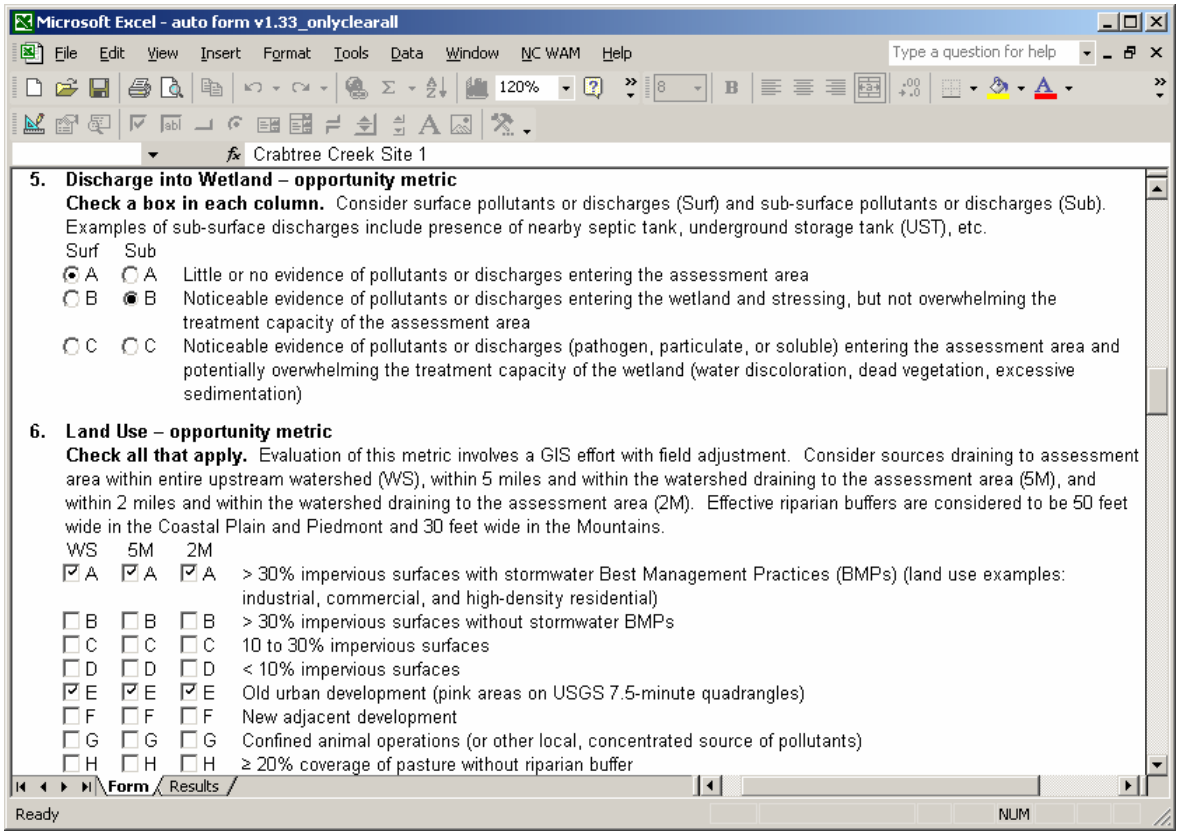



Figure K-4. Option buttons are used in metric number 5 for exclusive descriptors and checkboxes in metric number 6 for inclusive descriptors.

### K-2.2.2 Results Worksheet

The Results worksheet, the second worksheet in the Rating Calculator, displays general wetland information and calculated functional ratings in the same format found on the NC WAM Wetland Rating Sheet. The Results worksheet does not allow for any user input, but simply displays the wetland ratings as calculated. The general wetland information, such as wetland site name and wetland type, is automatically extracted from the general wetland information provided on the Form worksheet.

## K-2.3 Generating Functional Ratings

The process of calculating wetland functional ratings with the Rating Calculator is relatively simple: complete the NC FAM Field Assessment Form depicted in the Form worksheet by selecting the metric descriptors that apply to the assessed wetland. To be thorough, general wetland information, such as the wetland site name and date, should be completed as well. As

each metric is completed, the Rating Calculator automatically calculates the functional ratings for the sub-functions and functions that the metric pertains to. The calculated functional ratings are output to the Results worksheet. The rating for a particular sub-function, the Hydrology Surface Storage and Retention sub-function for instance, is displayed after metric descriptors have been provided for all metrics applicable to the sub-function, the Surface Storage and Retention sub-function in this case. An overall wetland rating is generated only after metric descriptors have been provided for all metrics applicable to the specified wetland type.

The Rating Calculator operates dynamically, meaning that wetland functional ratings are automatically calculated after each change in the metric descriptors, wetland type, or ecoregion. For instance, the Rating Calculator could be completed for a Piedmont Bottomland Hardwood Forest – metric descriptors provided for all necessary metrics and all functional ratings calculated. If a metric descriptor is changed for any metric, the Rating Calculator will automatically recalculate the functional ratings. If it were determined, after ratings calculation, that the wetland should be revised from Bottomland Hardwood Forest to Riverine Swamp Forest, all that would be required to recalculate the functional ratings is to select the new wetland type (Riverine Swamp Forest) from the Wetland Type combo box on the Form worksheet.

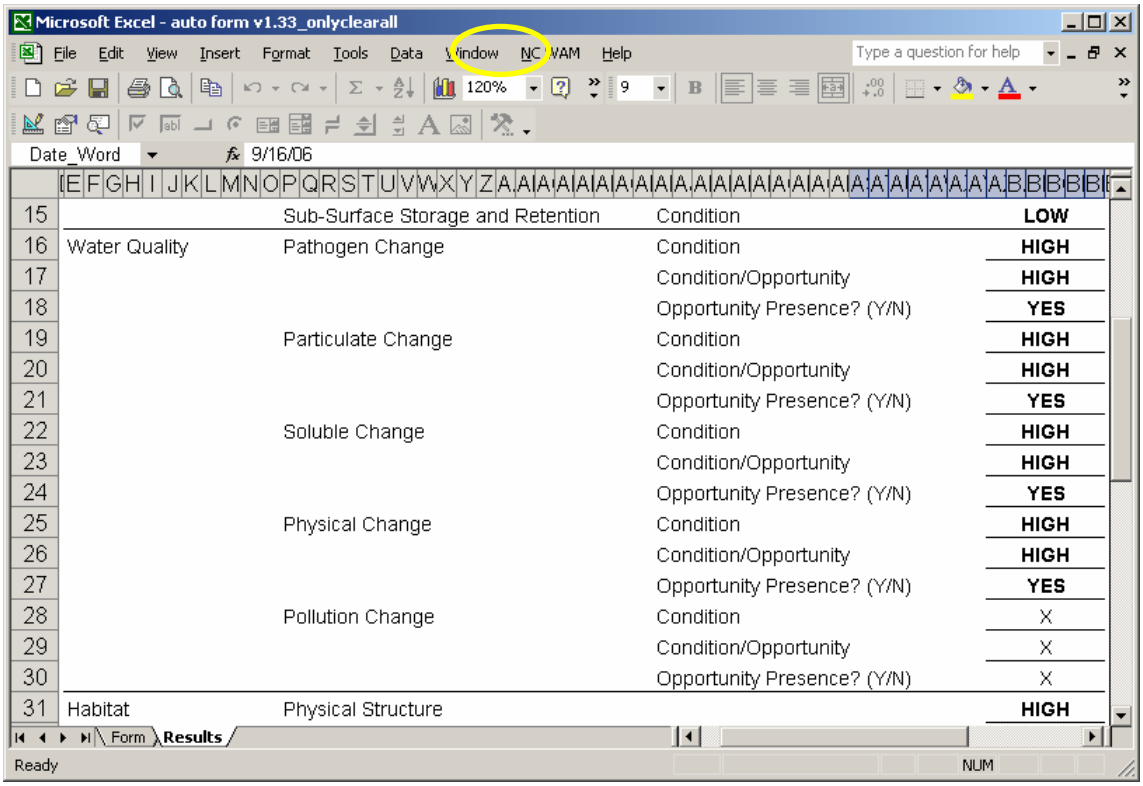
The wetland type and ecoregion are required information for all wetland assessments. Functional ratings can not be generated until a wetland type and ecoregion are selected in the Wetland Type and Level III Ecoregion combo boxes. In fact, the Rating Calculator produces a message with instructions to specify the wetland type and ecoregion if metric descriptors are selected beforehand. In addition, the functional assessments of the Bottomland Hardwood Forest and Riverine Swamp Forest wetland types require a stream type (blackwater or brownwater) to be specified. Again, the Rating Calculator produces a message with instructions to provide a stream type if a Bottomland Hardwood Forest or Riverine Swamp Forest assessment is attempted without first specifying the stream type.

### K-2.4 Viewing the Results

The Results worksheet can be viewed at any point in completing the Wetland Assessment Form on the Form worksheet by selecting the Results tab. The Results worksheet displays functional ratings for the sub-functions and functions completed to that point. For instance, if only metrics pertaining to the Habitat Physical Structure sub-function have been completely specified, then only the Habitat Physical Structure sub-function rating will be displayed on the Results worksheet.

As previously stated, the Results worksheet displays functional ratings and general wetland information without allowing any user input. The functional ratings presented are determined by the imbedded macros, while the general wetland information is transferred from the Form worksheet. If no general wetland information is provided on the Form worksheet, then none will be presented on the Results worksheet.

A total of 11 Hydrology, Water Quality, and Habitat sub-functions are presented on the NC WAM Wetland Rating Sheet and, consequently, the Results worksheet. Only a sub-set of the 11 sub-functions will apply to a given general wetland type. For instance, the Water Quality Pollution Change sub-function does not pertain to riverine wetlands such as Bottomland Hardwood Forests or Riverine Swamp Forest. In such cases, an "X" will appear in place of a sub-function rating to indicate that the sub-function is not applicable to the selected general wetland type (see Figure K-5).




| | | | | |
|---|---|---|---|---|
| 15 | | Sub-Surface Storage and Retention | Condition | LOW |
| 16 | Water Quality | Pathogen Change | Condition | HIGH |
| 17 | | | Condition/Opportunity | HIGH |
| 18 | | | Opportunity Presence? (Y/N) | YES |
| 19 | | Particulate Change | Condition | HIGH |
| 20 | | | Condition/Opportunity | HIGH |
| 21 | | | Opportunity Presence? (Y/N) | YES |
| 22 | | Soluble Change | Condition | HIGH |
| 23 | | | Condition/Opportunity | HIGH |
| 24 | | | Opportunity Presence? (Y/N) | YES |
| 25 | | Physical Change | Condition | HIGH |
| 26 | | | Condition/Opportunity | HIGH |
| 27 | | | Opportunity Presence? (Y/N) | YES |
| 28 | | Pollution Change | Condition | X |
| 29 | | | Condition/Opportunity | X |
| 30 | | | Opportunity Presence? (Y/N) | X |
| 31 | Habitat | Physical Structure | | HIGH |

Figure K-5. Sub-functions not applicable to a given general wetland type are indicated by an "X" on the Results worksheet. The NC WAM menu is provided on the menu bar.

## K-2.5 NC WAM Menu

Beyond the user interfaces described above for the Form worksheet (Section K-2.2.1), the Rating Calculator also includes an NC WAM dropdown menu in the Worksheet Menu Bar (Figure K-5). The NC WAM menu is a customized dropdown menu that provides access to the Rating Calculator Clear and Write to Word functions.

### K-2.5.1 Clear Function

The "Clear" function clears all contents of the Form and Results worksheets including general wetland information, metric descriptor selections, and functional ratings. This function allows a new functional rating calculation to be started on clean Form and Results worksheets. To access the Clear function, select Clear from the NC WAM menu (NC WAM|Clear).

### K-2.5.2 Write to Word Function

The "Write to Word" function (NC WAM|Write to Word) compiles the contents of the Form and Results worksheets into a single Microsoft Word document. Like the Rating Calculator, the resulting Word document is formatted to include both the NC WAM Wetland Assessment Form and the NC WAM Wetland Rating Sheet. All items from the Form worksheet, such as general wetland information and metric descriptor selections, are transferred to the corresponding locations in the NC WAM Wetland Assessment Form of the Word document. All items on the Results worksheet are transferred to the corresponding locations in the NC WAM Wetland Rating Sheet of the Word document.

Distributed with the Rating Calculator Excel file is the WetlandTemplate.dot file. The Write to Word function requires the WetlandTemplate.dot file to operate. The WetlandTemplate.dot file is a Microsoft Word template file used by the Write to Word function to reconstruct the formatting of the NC WAM Wetland Assessment Form and the NC WAM Wetland Rating Sheet. While not necessary, it is recommended that the WetlandTemplate.dot file reside in the same directory as the Rating Calculator Excel file. If the WetlandTemplate.dot file is not stored in the same directory as the Rating Calculator when the Write to Word function is accessed, a dialog will appear asking for the location of the WetlandTemplate.dot file to be specified.

To initiate the Write to Word function, select Write to Word from the NC WAM menu (NC WAM|Write to Word). The Save As dialog appears. Navigate to the desired directory of the new Word document and provide a file name. Click Save. The Write to Word function transfers the contents of the Form and Results worksheets to the newly created Word document.

The Word document created by the Write to Word function is a digital record of the wetland assessment. This is in contrast to the Rating Calculator itself, which is designed primarily as wetland functional rating calculator and is not intended to be a storage bin for wetland assessments. Compared to the Rating Calculator, the Word document created by the Write to Word function has a smaller file size and the contents are easier to incorporate into reports or other documents.

## K-3.0 Conclusions

The extensive Boolean logic chains developed by the WFAT for each of NC WAM's 16 general wetland types have conveniently been encoded into the NC WAM Rating Calculator. By linking the Boolean logic chains to an intuitive user interface that resembles the NC WAM Wetland Assessment Form, the Rating Calculator expedites the conversion of wetland assessment data to functional ratings by eliminating the arduous and error-prone task of manual processing. The Rating Calculator can export a completed wetland assessment – general wetland information, metric description selections, functional ratings, etc. – to a Word Document for storage or integration into a report. In all, the Rating Calculator provides a quick, user-friendly means of processing wetland assessment data collected using NC WAM, while at the same time ensuring the integrity of the data processing.

# APPENDIX L

## Glossary of Terms

## Appendix L: NC WAM Glossary of Terms

50/20 rule (for "dominant" vegetation) – This is the recommended method for selecting dominant species from a plant community when quantitative data are available. "Dominance" refers strictly to the spatial extent of a species that is measurable in the field (measures may include percent areal cover and basal area). The most abundant species (when ranked in descending order of abundance and cumulatively totaled) that immediately exceeds 50 percent of the total dominance measure for a given stratum, plus any additional species comprising 20 percent or more of the total dominance measure for that stratum, are considered dominant species for the stratum (USFWS et al. 1989).

Agriculture (land use) – Agriculture is considered to be a land use wherein the ground surface is regularly plowed and planted with row crops.

Anadromous fish – According to the NCDWQ, this term refers to fish that spend their adult life at sea, but swim up-river to fresh water spawning grounds to reproduce. Examples include shad, herring, and striped bass (http://www.enr.state.nc.us/html/a_-_terms.html). According to the National Marine Fisheries Service, the term "anadromous" refers only to those fish that spawn in freshwater and live most of their lives in salt water. This term is often used interchangeably with "diadromous." The term 'diadromous' refers to any fish that migrates between saltwater and freshwater (http://www.nmfs.noaa.gov/habitat/habitatprotection /anadromousfish.htm).

Anastomosing (braided) channels – A multiple channel system in which channels disconnect and reconnect typically found in situations characterized by low slope or depositional fans.

Area of Environmental Concern (AEC) – Within 20 designated coastal counties, an area designated by the Coastal Resources Commission (CRC) as being a particularly fragile or critical resource of state-wide concern. AECs are organized into four categories: the Estuarine and Ocean System, the Ocean Hazard System, Public Water Supplies, and Natural and Cultural Resource Areas. AECs are the foundation of the CRC's permitting program for coastal development, as administered by the N.C. Division of Coastal Management (NCDCM 2001).

Artificial edge – see Edge effect/artificial edge.

Assessment area – This term, also known as "wetland assessment area," refers to a defined area of wetland which is subjected to functional evaluation using the North Carolina Wetland Assessment Method (NC WAM). The boundary of the assessment area may be determined by the boundary of a proposed activity, the wetland type boundary, or the extent of a wetland type with a specific set of characteristics in common. Assessment area condition metrics are those concerned only with the portion of wetlands included within the defined assessment area, regardless of the location of general wetland type boundaries.

Benefit(s) (wetland) – Within NC WAM, a benefit may be one of several wetland functional products provided by identified wetland sub-functions. For instance, the wetland function of Hydrology is considered to comprise two sub-functions: surface storage and retention and sub-surface storage and retention. Benefits of surface storage and retention include energy

dissipation, reduction in runoff volume, and reduced flow velocities; and benefits of sub-surface storage and retention include attenuation of peak flows and maintenance of stream base flow.

Best Management Practices (BMPs) – This term refers to a structural or nonstructural management-based practice used singularly or in combination to reduce non-point source inputs to receiving waters in order to achieve water quality protection goals (15A NCAC 02B .0202).

Best Professional Judgment (BPJ) – Utilization of accumulated experience in a given field to make a decision appropriate to the specific wetland at hand. NC WAM attempts to be as specific as possible, but the variability of wetlands and limited quantitative knowledge of some metrics make it necessary to rely on BPJ in many instances.

Blackwater streams – Coastal Plains (Middle Atlantic Coastal Plain and Southeastern Plains ecoregions) streams that contain negligible amounts to no sediment, are tannic in nature, and often flow through peat-based or sandy areas (NCDWQ 1997a). These streams are often black in color but are not turbid like brownwater streams.

Blue Ridge Moutains level III ecoregion – This ecoregion occurs within generally the same footprint as the Blue Ridge physiographic province (see Figure 1 and Appendix F for ecoregion map). The Blue Ridge Mountains ecoregion includes the mountainous portion of the old Appalachians Highland and varies in character from narrow ridges to hilly plateaus to more massive mountainous areas with high peaks. This ecoregion occurs on metamorphic rocks with minor areas of igneous and sedimentary geology (Griffith et al. 2002).

Blue Ridge physiographic province –This physiographic province is synonymous with Blue Ridge Mountains level III ecoregion (see Figure 1 and Appendix F).

Boolean logic – 1) This is a method of converting logical expressions into mathematical form and is based on a binary approach, processing only two objects at a time. 2) A deductive logical system usually applied to classes in which, under the operations of intersection and symmetric difference, classes are treated as algebraic quantities. Boolean logic is the basis of the algorithms converting the field metrics of NC WAM into functional ratings.

Brackish water – Waters typically found in the upper extent of estuaries and the lower reaches of large rivers. These waters typically have a saline content of greater than 0.5 parts per thousand. This is a term used by NC WAM to refer to estuarine waters at the lower end of the salinity concentration scale.

Braided (anastomosing) channels – See Anastomosing (braided) channels

Brownwater streams – Streams that generally originate in the Piedmont or Blue Ridge Mountains ecoregions of North Carolina (NCDWQ 1997a). These streams often contain high amounts of clay and silt and are therefore often turbid and brown in color.

Buffer – A buffer is a vegetated area adjacent to a water body that reduces runoff and non-point source pollution by decreasing water flow velocity. This facilitates the settling, trapping and uptake of chemical pollutants (such as nitrogen and phosphorus) and sediment (http://www.enr.state.nc.us/html/b_-_terms.html). The NC WAM considers optimum buffer

widths to be 50 feet wide (measured perpendicular to a surface water) in the Coastal Plain and Piedmont ecoregions and 30 feet wide (measured perpendicular to a surface water) in the Blue Ridge Mountains ecoregion.

Buffer (Riparian) – A buffer is a vegetated area adjacent to a water body that reduces runoff and non-point source pollution and attenuates flood flows by decreasing water flow velocity. This facilitates the settling, trapping and uptake of chemical pollutants (such as nitrogen and phosphorus) and sediment (http://www.enr.state.nc.us/html/b_-_terms.html). NC WAM considers optimum buffer widths to be 50 feet wide (measured perpendicular to a surface water) in the Coastal Plain and Piedmont ecoregions and 30 feet wide (measured perpendicular to a surface water) in the Blue Ridge Mountains ecoregion

Canopy – The canopy is the uppermost layer of vegetation in a plant community. In forested areas, mature trees comprise the canopy layer, while the tallest herbaceous species constitute the canopy layer in a marsh (Environmental Laboratory 1987).

Channel – A channel is a natural water-carrying trough cut vertically into low areas of the land surface by erosive action of concentrated flowing water or a ditch or canal excavated for the flow of water (15A NCAC 02B .0233 (2)(a)).

Chroma – The relative purity or saturation of a color; intensity of distinctive hue as related to grayness; one of the three variables of color (Environmental Laboratory 1987).

Class SA waters – A NCDWQ classification for the highest quality tidal salt waters. These are surface waters that are used for shell fishing for market purposes and meet the current sanitary and bacteriological standards as adopted by the Commission for Health Services (15A NCAC 02B .0221).

Coastal island – An island surrounded by salt, estuarine, or brackish water.

Coastal Plain ecoregions – Term used within the NC WAM User Manual to collectively refer to the Middle Atlantic Coastal Plain and Southeastern Plains level III ecoregions.

Coastal Plain physiographic province – The Coastal Plain is a physiographic province that includes all areas extending eastward from the fall line/fall zone to the ocean. It consists of the areas with surface geology consisting of Cretaceous and younger sedimentary rocks and unconsolidated sediments. This physiographic province includes the Middle Atlantic Coastal Plain and Southeastern Plains level III ecoregions – as well as the Sandhills level IV ecoregion (see Figure 1 and Appendix F).

Condition metric – This type of metric is a measurement of the extent to which a wetland departs from full wetland functional integrity. In other words, a condition metric is any metric which is based on the inherent capacity of a wetland to perform functions. NC WAM uses condition as a surrogate for function because “condition” can be observed while “function” must be inferred.

Confined animal operations – Facilities associated with production of animal products through the raising of livestock in large numbers in a limited space, resulting in the concentration of animal byproducts in on-site locations.

Connectivity to other natural areas – A concept utilized by the Habitat wetland function which refers to the absence or presence and type of fragmentation, and barriers to migration (both biotic [animals and plants] and abiotic [water and nutrients]) into and out of a specific wetland system.

Crenulation – This term refers to a linear topographic feature that is less well developed than a stream channel or valley. Crenulations may be described as a topographic notch, scallop, or reentrant. Crenulations are typically smaller-scale, localized features rather than larger-scale, landscape features. Also see "reentrant."

Decimal-degrees – This term refers to "decimal degrees," the expression of a latitude or longitude in degrees only (not minutes and seconds), typically written to six digits.

Dendritic channels – A multiple channel system in which the channels do not reconnect. The large scale drainage pattern in most places in North Carolina is dendritic, with low order streams flowing into higher order streams.

Deposition/sedimentation – This term refers to the settling out and accumulation of eroded soil material (sediment) that has been transported into a wetland or open water system by moving water. "Recent deposition" is defined as not supporting new plant growth.

Development – Any land disturbing activity which adds to or changes the amount of impervious or partially impervious cover on a land area or which otherwise decreases the infiltration of precipitation into the soil (15A NCAC 02B .0202).

Diameter at Breast Height (DBH) – The width of a plant stem as measured at 4.5 feet above the ground surface (Environmental Laboratory 1987).

Discharge – For the purpose of NC WAM, this term refers to a substance that is released into a wetland. A discharge may be liquid or solid and may have a point or a non-point source.

Descriptor – On the NC WAM field assessment form, each metric is in the form of a question which provides from one to several possible answers. The answer or answers selected by an assessor are referred to as "descriptors." The descriptors are used by NC WAM to determine functional ratings for a wetland.

Ditch, deep – A "ditch" or "canal" is a man-made channel other than a modified natural stream constructed for drainage purposes. Ditches are typically dug through inter-stream divide areas. A ditch or canal may have flows that are perennial, intermittent, or ephemeral and may exhibit hydrological and biological characteristics similar to perennial or intermittent streams. (15A NCAC 02B .0233(2)(d)). To be effective, a ditch must have an outlet (the ditch must eventually connect to a water body). A "deep" ditch has been excavated at a sufficient depth to potentially affect both surface and sub-subsurface storage and retention. For the purposes of NC WAM, a "deep" ditch typically exceeds 1 foot deep in mineral soils. If a soil has an organic surface layer, a "deep" ditch will extend into the underlying mineral soil layer.

Ditch, shallow – A "ditch" or "canal" is a man-made channel other than a modified natural stream constructed for drainage purposes. Ditches are typically dug through inter-stream divide areas. A ditch or canal may have flows that are perennial, intermittent, or ephemeral and may exhibit

hydrological and biological characteristics similar to perennial or intermittent streams. (15A NCAC 02B .0233(2)(d)). To be effective, a ditch must have an outlet (the ditch must eventually connect to a water body). A "shallow" ditch has been excavated to a depth sufficient to potentially affect surface water storage and retention, but is not deep enough to affect sub-surface storage and retention. For the purposes of NC WAM, a "shallow" ditch typically does not exceed 1 foot deep in mineral soils. If a soil has an organic surface layer, a "shallow" ditch will not extend into the underlying mineral soil layer.

Dominant/dominated by – A biological, chemical, or physical feature that exerts a controlling influence on or defines the character of a community (modified from Environmental Laboratory 1987). For example: 1) one or a few species of trees may "dominate" a forest canopy, making up the majority of the tree cover or basal area; 2) the lower Albemarle Sound may be considered to be dominated by salt or brackish water even though the introduction of salt or brackish water occurs on an irregular basis.

DWQ Stream Classification Form – A form developed by the N.C. Division of Water Quality in 2005 to be used in conjunction with state regulations concerning the protection and maintenance of existing riparian buffers (15A NCAC 02B .0233 - .0261). The purpose of the form is to assist an evaluator in the field with a determination of the point at which a forming stream transitions from an ephemeral (stormwater) channel to an intermittent channel and from an intermittent channel to a perennial channel.

Ecological domain – Ecological domain refers to the characteristic group from which reference wetlands are selected. For instance, Pocosins may be found on mineral soils or organic soils. A reference for a mineral soil Pocosin will be drawn only from the ecological domain of mineral soil Pocosins.

Ecoregion – Ecoregions denote areas of general similarity in ecosystems and in the type, quality, and quantity of environmental resources. The delineation of ecoregions is based on the premise that ecological regions are hierarchical and can be identified through the analysis of spatial patterns and compositions of biotic and abiotic phenomena that affect or reflect differences in ecosystem quality and integrity. These phenomena include geology, physiography, vegetation, climate, soils, land use, wildlife, and hydrology. A Roman numeral hierarchical scheme has been adopted for different levels of ecological regions (Griffith et al. 2002). NC WAM primarily uses level III ecoregions because of the ease in translation between these units and the standard physiographic provinces. The Coastal Plain physiographic province contains the Middle Atlantic Coastal Plain and Southeastern Plains level III ecoregions; the Piedmont physiographic province roughly equals the Piedmont level III ecoregion; and the Blue Ridge physiographic province roughly equals the Blue Ridge Mountains ecoregion.

Edge effect/artificial edge – Edge effect is the alteration of physical environment and ecological function that results from a boundary between two contrasting kinds of vegetation. Of particular concern is the effect of artificial clearings adjacent to forests. These artificial edges increase weedy plant growth and increase the activity of certain predators and nest parasites for some distance into the forest from the edge. Certain species (forest interior species) are particularly harmed by artificial edges. A maintained corridor less than or equal to the width of a two-lane

road is generally not considered to be an artificial edge. A maintained corridor greater than 40 feet wide is usually considered to be an artificial edge. Edge effect is evaluated as a metric for the Habitat wetland function.

Embayed region – A portion of the Middle Atlantic Coastal Plain ecoregion in northeastern North Carolina and adjacent Virginia. The embayed region is characterized by the prominence of drowned river valleys which form large sounds and many bays. The land in the embayed region is universally low and flat, and most is partly drained. This region contains the largest acreage and proportion of wetlands in the state (NCDWQ 1997b).

Estuarine water – Waters semi-enclosed by land but with at least partial access to the open ocean and in which ocean water is at least occasionally diluted by freshwater runoff from the land. The estuarine system extends landward to where ocean-derived salts measure less than 0.5 parts per thousand during a period of average annual flow and seaward to the ocean (Cowardin et al. 1979). Brackish water, as used by NC WAM, is a subset of estuarine water at the lower end of the salt concentration (the vicinity of just over 0.5 parts per thousand).

Excessive sediment – WFAT utilized best professional judgment to determine that, in general, greater than 4 inches of recent sediment deposition is considered excessive sediment deposition. Also, 1 to 4 inches of recent sediment deposition is considered an intermediate amount, and less than 1 inch of recent sediment deposition is considered a small amount of sediment deposition.

Exotic species/exotics – This designation includes species that are not indigenous to a region – intentionally or accidentally introduced and often persisting (USACE 2006). See Appendix I for a list of species considered to be exotic in North Carolina. While numerous exotic species occur in North Carolina, the emphasis for NC WAM is on those which are invasive, with the ability to become abundant in natural or disturbed wetlands and displace or prevent recovery of native species.

Exposed areas (with reference to marshes adjacent to open water) – Shorelines anticipated to be regularly subject to waves of a height of 1 foot or more are considered to be "exposed." NC WAM considers an open water width of 2500 feet to provide sufficient fetch for regular development of waves meeting or exceeding this threshold. Also, shorelines adjacent to open water with regular boat traffic that generates high-energy wakes are considered to be "exposed." "Sheltered areas" are the opposite of "exposed areas."

Fall line – The fall line or fall zone is a narrow zone encompassing a change in topography that separates the Piedmont and Coastal Plain physiographic provinces. Within this zone, the uplift of the Piedmont and Blue Ridge physiographic provinces has resulted in accelerated erosion, which, in turn, has resulted in a band of rapids and steep-sided valleys (Beyer 1991).

Few – "Few" is a relative term used in this assessment to indicate an amount less than 25 percent of the total present within the assessment site.

Federally protected species – Species with federal classifications of Endangered or Threatened are protected under the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq*.). Endangered status refers to "any species which is in danger of extinction throughout all

or a significant portion of its range," and Threatened status refers to "any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range" (16 U.S.C. 1532).

Floodplain, active – The land beside a river that receives overbank flooding when discharge exceeds channel capacity (USACE 2006).

Floodplain, geomorphic – A valley formed in the past by floods which extended to the valley walls. For the purpose of NC WAM, a geomorphic floodplain is a topographic feature and, for any number of reasons, may no longer be subject to periodic flooding.

Flow, groundwater – This term refers to water that flows below the land surface through a porous medium normally under saturated conditions (USACE 2006).

Flow, near-surface – This term refers to flow that occurs just below the surface of a wetland in a layer that is often more permeable than the more consolidated sediments just below. Near-surface flow often occurs in the rhizosphere where hydraulic permeability is high (USACE 2006).

Flow, surface – This term refers to non-channelized flow (unchannelized) that occurs above the surface or overland flow (USACE 2006).

Forested wetland – In general, a forested wetland is characterized by over 50 percent coverage of woody vegetation that is 10 feet or taller (modified from NCDEM 1995). Specifically for the purposes of NC WAM, a general wetland type that supports forest (see previous sentence) in reference condition. NC WAM forested wetland types include Bottomland Hardwood Forest, Riverine Swamp Forest, Headwater Wetland, Floodplain Pool, Pocosin (some forms), Hardwood Flat, Pine Flat (some forms), Pine Savanna (some forms), Small-basin Wetlands (some forms), Non-Riverine Swamp Forest, Mountain Bog (some forms), Seep, and Estuarine Woody Wetland (some forms).

Freshwater – Waters which contain less than 0.5 parts per thousand of ocean-derived salts (Cowardin et al. 1979).

Function – The normal activities or actions that occur in wetland ecosystems, or simply, the things that wetlands do. Wetland functions result directly from the characteristics of a wetland ecosystem and the surrounding landscape, and their interaction. The term is used primarily as a distinction from values. The term "values" is associated with society's perception of ecosystem functions. Functions occur in ecosystems regardless of whether or not they have values (definition modified from USACE 2006).

Functional assessment – The process by which the capacity of a wetland to perform a function is measured or estimated (definition modified from USACE 2006).

Functional rating – See "rating."

Geographic Information System (GIS) – A computer system for capturing, storing, checking, integrating, manipulating, analyzing and displaying data related to positions on the Earth's surface. Typically, a GIS is used for handling maps of one kind or another. These might be

represented as several different layers where each layer holds data about a particular kind of feature (e.g. roads). Each feature is linked to a position on the graphical image of a map.

Gleyed – A soil condition resulting from prolonged soil saturation, which is manifested by the presence of bluish or greenish colors through the soil mass or in mottles (spots or streaks) among other colors. Gleying occurs under reducing soil conditions resulting from soil saturation, by which iron is reduced predominantly to the ferrous state (Environmental Laboratory 1987).

Groundwater – Groundwater is water occurring beneath the ground surface under saturated conditions (modified from 15A NCAC 02L .0102(11) (see also Flow, groundwater).

Groundwater discharge – Water originating from an aquifer that flows to the surface (USACE 2006).

Groundwater inflows – Flow of water received by a wetland or some other area as a result of groundwater discharge via lateral seepage or upward movement (USACE 2006).

Groundwater recharge – Flow of water from an area that contributes to an aquifer. Most upland areas contribute to groundwater recharge (USACE 2006).

Growing season – The portion of the year when soil temperatures at 19.7 inches below the soil surface are higher than biologic zero (5°C). For ease of determination, this period can be approximated by the number of frost-free days (Environmental Laboratory 1987). For the purpose of NC WAM, the extent of the growing season for a specific site is available in the local county soil survey.

Guidance for Rating the Values of Wetlands in North Carolina: Fourth Version – Guidance generated in 1995 by the N.C. Division of Environmental Management (NCDEM 1995) and intended for use with freshwater wetlands to assist regulatory agencies in making determinations concerning the values of wetlands.

Habitat – The environment occupied by individuals of a particular species, population, or community (Environmental Laboratory 1987). The provision of terrestrial and aquatic habitat is considered by NC WAM to be one of the three primary functions of wetlands.

Habitat uniqueness – This term refers to an NC WAM metric based on the N.C. Environmental Management Commission (EMC) "Unique Wetlands" classification. "Unique Wetlands are defined in the state water quality standards (15A NCAC 2B .0101 [e][7]) as follows: wetlands of exceptional state or national ecological significance, which require special protection to maintain existing uses. These wetlands may include wetlands that have been documented to the satisfaction of the Commission as habitat essential for the conservation of state or federally listed threatened or endangered species." A determination of habitat uniqueness will be made by the EMC. An assessor will need to review EMC publications in order to evaluate this metric.

Herb – Non-woody plants including graminoids, forbes, ferns, fern allies, and herbaceous vines as well as shrub and tree seedlings less than 3 feet tall (Federal Manual for Identifying and Delineating Jurisdictional Wetlands, Part III, USACE et al. 1989).

Herbaceous layer – Any vegetative stratum of a plant community that is composed predominantly of herbs (Environmental Laboratory 1987).

High-density residential (land use) – This term refers to residential development characterized by greater than 30-percent impervious surfaces for the purpose of NC WAM.

High Quality Waters (HQW) – Waters which are rated by the state as excellent based on biological and physical/chemical characteristics as determined by NCDWQ monitoring or special studies, and are accordingly classified by the Environmental Management Commission (NCDEM 1995).

Histic epipedon – A thick (8- to 16-inch) soil layer at or near the surface that is saturated for 30 consecutive days or more during the growing season in most years and contains a minimum of 20 percent organic matter when no clay is present or a minimum of 30 percent organic matter when 60 percent or greater clay is present (Environmental Laboratory 1987).

Histosols – Soils that have organic soil material in more than half of the upper 32 inches or that are of any thickness if overlying rock or fragmental materials have interstices filled with organic soils materials (USDA 2003)

Hydric soil – A soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part that favor the growth and regeneration of hydrophytic vegetation (Environmental Laboratory 1987).

Hydrologic regime – The distribution and circulation of water in an area, on average, during a given period including normal fluctuations and periodicity (USACE 2006).

Hydrology – The science dealing with the properties, distribution, and circulation of water (USACE 2006). Also, Hydrology, the provision of surface and near-surface water, is considered by NC WAM to be one of the three primary functions of wetlands.

Hydroperiod – This term refers to the depth, duration, seasonality, and frequency of flooding (USACE 2006).

Hydrophytic (vegetation) – This term refers to plant life growing in water or on a substrate that is at least periodically deficient in oxygen as a result of excessive water content (Environmental Laboratory 1987).

Impervious surface – A surface where water infiltration is impeded by impermeable materials on top of the soil (examples: concrete, asphalt, roof tops) (NCDEM 1995).

Inner Coastal Plain – This physiographic area is synonymous with the Southeastern Plains level III ecoregion (see also) excepting the Sandhills level IV ecoregion (see Figure 1 and Appendix F for ecoregion maps). This area consists of irregular plains with broad interstream areas.

Intensively-managed wetlands – Wetlands that have been subject to on-going disturbance such that they 1) are degraded examples of the natural wetland type or 2) have been modified so that the stable, existing wetland type better resembles another wetland type than the original because the modification has remained on-going (and will likely remain so for the foreseeable future).

Interstream flat/divide – This term refers to the geographic position in the landscape for a wetland which is found between two or more streams. Usually the interstream flat or divide does not have natural stream channels, although ditches may now connect this area to natural stream courses. This term includes ridges and saddles in the Piedmont and Blue Ridge Mountains ecoregions.

Interstream wetlands – A term referring to wetland types typically not found in a geomorphic floodplain, not associated with a natural linear conveyance, and not associated with a natural lake greater than or equal to 20 acres in size (see NC WAM wetland type key). Interstream wetlands include the following NC WAM general wetland types: Seep, Hardwood Flat, Non-Riverine Swamp Forest, Pocosin, Pine Savanna, Pine Flat, and Small-Basin Wetland. Assessors should remember that there are exceptions to most rules. For instance, these listed wetland types may occur in geomorphic floodplains within the embayed region of the state.

Inundation – A condition in which water from any source temporarily or permanently covers a land surface (Environmental Laboratory 1987). This term is inclusive of flooding and ponding.

Landscape patch – The contiguous natural habitat that includes the assessed wetland type regardless of whether the natural habitat is located within the watershed of the assessed wetland type.

Landscape position – This term refers to the location of a wetland in the watershed. Headwater wetlands, for example, are in the upper reaches of a watershed adjacent to zero- to first-order streams as depicted on USGS 7.5-minute topographic quadrangles, while bottomland systems are typically lower in the watershed adjacent to larger (second or higher order) streams and rivers.

Land Use: Agriculture – Agriculture is considered to be a land use wherein the ground surface is regularly plowed and planted with row crops.

Land Use: Pasture – Pasture is considered to be a land use wherein the ground surface is maintained in grasses and herbs to provide forage for livestock. Hay fields, which typically are not plowed, would be considered in this category.

Large woody debris – This term refers to woody material found on the ground surface. The term “large” typically refers to woody material greater than 12 inches in diameter. Large woody debris serves to slow surface water flows, contain surface inundation, and provide animal habitat. The source of large woody debris (natural or man-placed) is immaterial to NC WAM.

Level III ecoregion – See “ecoregions.”

Linear conveyance – An open conduit either naturally or artificially created which periodically or continuously contains moving water, or which forms a connecting link between two bodies of standing water (examples: stream, ditch, canal) (Langbein and Iseri 1960). For the purpose of NC WAM, a “natural” linear conveyance excludes man-made features.

Long-duration inundation – This term refers to an inundation class in which the period of flooding or ponding for a single event ranges from 7 days to 1 month during the growing season (Environmental Laboratory 1987).

Long-established, permanent alteration – This term refers to a modification that has occurred to a wetland, which has remained on-going, and will likely remain so for the foreseeable future (examples: maintained utility line corridor, floodplain inundated by beaver activity). A modified wetland is considered to be characterized by a "long-established, permanent alteration" if it is currently in a stable condition.

Loosely connected – Wetlands considered to be loosely connected include narrow corridors of natural habitat or broader connections through unnatural habitats through which wildlife may pass, such as pine plantations or mosaics of cropland and woodland.

Low-density residential (land use) – This term refers to residential development characterized by less than 10 percent impervious surfaces for the purpose of NC WAM.

Mafic depression – For the purpose of NC WAM, "mafic depression" is a sub-type of Small-Basin Wetland. Mafic depression is also a subset of the N.C. Natural Heritage Program community Upland Depression Swamp Forest (Schafale and Weakley 1990). Mafic depressions occur over mafic igneous or metamorphic rock on interstream divides and are surrounded by upland. Characteristic clay soils slow drainage and result in wetland hydrology that ranges from saturation to intermittent to seasonal inundation. Mafic depressions typically support a closed tree canopy, sparse shrubs, and scattered ground cover.

Maintained fields – This term refers to land that is actively maintained (mowed, plowed, sprayed with pesticides and/or herbicides) in a relatively open state (examples: agricultural row crops, pasture, sod farm, orchard, Christmas-tree farm, nursery tree farm).

Many – "Many" is a relative term used in this assessment to indicate an amount between 25 and 50 percent of the total.

Marsh – This term refers to semi-permanently to permanently flooded or saturated wetlands that are dominated by herbaceous vegetation (NCDEM 1995).

Medium-density residential (land use) – This term refers to residential development characterized by between 10 and 30 percent impervious surfaces for the purpose of NC WAM.

Metric – An environmental variable used as a surrogate indicator in the process of determining the level of function a wetland is currently performing. Field metric ratings may involve direct measurement or best professional judgment.

Microtopographic relief – This term refers to the depressional storage capacity of a wetland that results from to subtle changes (generally less than 1 foot) on the soil surface (NCDEM 1995). For the purposes of this assessment, relatively shallow man-made depressions, such as skidder ruts, are given equal consideration with natural depressions.

Middle Atlantic Coastal Plain level III ecoregion – This ecoregion occurs in the eastern portion of the Coastal Plain physiographic province and includes the tidewater area and the associated bottoms of large rivers (see Figure 1 and Appendix F for ecoregion maps). NC WAM considers this ecoregion to be synonymous with the Outer Coastal Plain. The Middle Atlantic Coastal Plain ecoregion consists of low elevation, flat plains, with many swamps, marshes, and estuaries underlain by unconsolidated sediments. Poorly drained soils are common, and the

region has a mix of coarse and finer textured soils compared to the adjacent ecoregion to the west (Southeastern Plains) (Griffith et al. 2002).

Mineral soil – A mineral soil consists predominantly of, and has its properties determined predominantly by, mineral matter usually containing less than 20 percent organic matter (Environmental Laboratory 1987).

Most – "Most" is a relative term used in this assessment to indicate an amount greater than or equal to 50 percent of the total.

Mottles/mottled – These terms refer to spots or blotches of different color or shades of color interspersed within the dominant color in a soil layer, usually resulting from the presence of periodic reducing soil conditions (Environmental Laboratory 1987). See also "redoximorphic features."

Mountains physiographic province – See Blue Ridge Mountains level III ecoregion.

Muck – An organic soil material in which virtually all of the organic material is decomposed, not allowing for identification of plant forms (USDA 2003).

Muck soil – Soil with a layer of muck 0.5 inch or more thick with value 3 or less and chroma 1 or less starting within 6 inches of the soil surface (Indicator A9, 1 centimeter Muck, from Field Indicators of Hydric Soils in the United States, Version 5.9 [USDA 2005]).

Mucky mineral soil – Mineral soil with a mucky modified mineral layer 4 inches or more thick starting within the upper 6 inches of the soil (Indicator F1, Loamy Mucky Mineral soil, from Field Indicators of Hydric Soils in the United States, Version 5.9 [USDA 2005]).

National Technical Committee for Hydric Soils (NTCHS) Indicators – Field Indicators of Hydric Soils in the United States: Guide for Identifying and Delineating Hydric Soils (Version 6.0, USDA 2006 – most recent version a printing of this version, subject to change without notice) is a guide to help identify and delineate hydric soils in the field throughout the country. The most recent version can be found on-line at http://soils.usda.gov/use/hydric/. Field Indicators of Hydric Soils in the Mid-Atlantic United States (USEPA 2006) is an attempt to provide a regionalized guide to help identify and delineate hydric soils in the field within the Mid-Atlantic region.

Natural gaps – This term refers to gaps that may form in a forest canopy when trees fall as a result of "natural processes" such as lightning strikes, disease, and storms. Large, widespread canopy gaps, even to the point of canopy loss, due to fire (as in the case of Pine Savannas) or hurricane damage are considered natural gaps.

Natural habitat patch – This term refers to the entire naturally vegetated area around a wetland assessment area.

New urban development – This term refers to recent urban development which may not be indicated with pink shading on USGS 7.5-minute topographic quadrangles. It is assumed that new urban development will often utilize some level of stormwater measures.

Non-point source discharge – Pollution sources that do not have a single point of origin or are not introduced to a receiving stream from a specific outlet. Examples of non-point sources of

pollutants include farms, urban areas, residential developments, construction sites and forests. Non-point source pollution is generally carried into the water from the land by stormwater runoff (http://www.enr.state.nc.us/html/n_-_terms.html).

Non-riparian wetlands – Non-riparian wetlands are wetlands with no direct association to streams and rivers and that are not found in a geomorphic floodplain created by streams or rivers in the past.

Non-riverine wetlands – For the purpose of NC WAM, a term referring to wetland types typically found in a landscape position meeting the following criteria: not in a geomorphic floodplain and not associated with a natural linear conveyance nor associated with a natural lake greater than or equal to 20 acres in size (see NC WAM wetland type key). Non-riverine wetlands include the following NC WAM general wetland types: Seep, Hardwood Flat, Non-Riverine Swamp Forest, Pocosin, Pine Savanna, Pine Flat, Small-Basin Wetland, and some Non-Tidal Freshwater Marshes (when not in a geomorphic floodplain).

N.C. Scope and Effect Guide (for ditching in hydric soils) – A guide developed by the USDA to provide fast, uniform, and relatively accurate information on the effects of drainage ditches on soil saturation (the lateral effect of a drain in a given hydric soil) (U.S. Department of Agriculture, Natural Resources Conservation Service, Southeastern States Wetland Team, June 1998).

Northern Inner Piedmont level IV ecoregion – Located in the western Piedmont level III ecoregion (Appendix F), the Northern Inner Piedmont level IV ecoregion is rolling to hilly and has higher elevations, more rugged topography, and more monadnocks or mountain outliers than other areas of the Piedmont (Griffith et al. 2002).

Nuisance species – Species of plants that detract from or interfere with a mitigation project, such as most exotic species and those indigenous species whose populations proliferate to abnormal proportions (USACE 2006).

Old urban development – Development indicated with pink shading on U.S. Geological Survey 7.5-minute topographic quadrangles. It is assumed that old urban development typically lacks modern stormwater management measures.

Open water – This term refers to surface waters (streams, rivers, ditches, canals, and ponds without emergent vegetation).

Opportunity metric – WFAT implemented this type of metric to account for or infer watershed conditions which affect the level of performance of a wetland function. "Opportunity" can increase the amount of pollutant removal or hydrological amelioration a wetland provides by increasing the amount of pollutants or altered hydrology the wetland is exposed to. Opportunity only leads to increased function if the wetland has the capacity for performing additional function. In NC WAM, opportunity is scored as a modification to the score based on condition, with the combination of condition and opportunity metrics used to determine if the wetland has the capacity to respond to the opportunity.

Organic soil – A soil is classified as an organic soil when it is 1) saturated for prolonged periods and has more than 30 percent organic matter if the mineral fraction is more than 50 percent clay, or more than 20 percent organic matter if the mineral fraction has no clay; or 2) never

saturated with water for more than a few days and having more than 34 percent organic matter (Environmental Laboratory 1987).

Outer Coastal Plain – This physiographic area is synonymous with the Middle Atlantic Coastal Plain level III ecoregion (see also) (see Figure 1 and Appendix F for ecoregion maps). This area consists of low elevation, flat plains, with many swamps, marshes, and estuaries underlain by unconsolidated sediments.

Outstanding Resource Waters (ORW) – Unique and special waters of exceptional state or national recreational or ecological significance which require special protection to maintain existing uses and are accordingly classified by the Environmental Management Commission (NCDEM 1995).

Overbank flooding – Any situation in which inundation occurs as a result of the water level of a stream rising above bank level (Environmental Laboratory 1987).

Overland flow – Water movement above and parallel with the soil surface (USACE 2006).

Particulate Change – A sub-function under the water quality function of wetlands. Particulate change refers to the ability of a wetland to remove sediment and insoluble organic matter from the water column.

Pasture (land use) – Pasture is considered to be a land use wherein the ground surface is maintained in grasses and herbs to provide forage for livestock. Hay fields, which typically are not plowed, would be considered in this category.

Pathogen Change – A sub-function under the water quality function of wetlands. Pathogen change refers to the ability of a wetland to remove undesirable bacteria and viruses from the human environment.

Peat – A fibric organic soil material that has virtually all of the organic material allowing for identification of plant forms (USDA 2003).

Physiographic province – A region of which all parts are similar in geologic structure and which has consequently had a unified geomorphic history; a region whose pattern of relief features or landforms differs significantly from that of adjacent regions (www.webref.org/geology). The Coastal Plain physiographic province contains the Middle Atlantic Coastal Plain and Southeastern Plains level III ecoregions; the Piedmont physiographic province roughly equals the Piedmont level III ecoregion; and the Blue Ridge physiographic province roughly equals the Blue Ridge Mountains level III ecoregion.

Physical Change – A sub-function under the water quality function of wetlands. Physical change refers to the ability of a wetland to dissipate the energy of flowing water in order to prevent erosion.

Piedmont level III ecoregion – This ecoregion occurs within generally the same footprint as the Piedmont physiographic province (see Figure 1 and Appendix F for ecoregion maps). The Piedmont ecoregion is considered to be the non-mountainous portion of the old Appalachians Highland by physiographers and comprises a transitional area between the mostly mountainous ecoregions of the Appalachians to the west and the relatively flat Southeastern Plains to the

east. The Piedmont is a complex mosaic of Precambrian and Paleozoic metamorphic and igneous rocks with moderately dissected irregular plains and some hills. The soils tend to be finer-textured than in the Coastal Plain ecoregions (Griffith et al. 2002).

Piedmont physiographic province – The Piedmont physiographic province extends westward from the fall line (or fall zone) to the Blue Ridge escarpment. This physiographic province occurs generally within the same footprint as the Piedmont level III ecoregion (see Figure 1 and Appendix F).

Point source discharge – A stationery location or fixed facility from which pollutants are discharged or emitted. Also, any identifiable source of pollution such as a pipe, ditch, or ship (http://www.enr.state.nc.us/html/p_-_terms.html).

Pollutant – According to the NCDWQ, a pollutant is generally any substance introduced into the environment that adversely affects the usefulness or health of a resource (http://www.enr.state.nc.us/html/p_-_terms.html). According to the USACE, the following items are considered pollutants: dredged spoil, solid waste, incinerator residue, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials not covered by the Atomic Energy Act, heat, wrecked or discarded equipment, rock, sand, cellar dirt, and industrial, municipal, and agricultural waste discharged into water (Section 404(b)(1) Guidelines, 40 CFR Section 230.3). NC WAM accepts both definitions and adds both point source and non-point source discharges of stormwater. NC WAM considers salt to be a pollutant in freshwater wetlands.

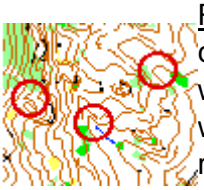
Ponded - A condition in which water stands in a closed depression (no outlet). Water may be removed only by percolation, evaporation, and/or transpiration (USACE 2006).

Prevalent – Abundant, but not necessarily the most abundant.

Primary Nursery Area (PNA) – Tidal salt waters which provide essential habitat for the early development of commercially important fish and shellfish and are so designated by the Marine Fisheries Commission (15A NCAC 02B .0202).

Rating (functional rating) – NC WAM generates an overall functional rating for each wetland type within an assessment area. In addition, ratings are generated for component wetland functions (Hydrology, Water Quality, and Habitat; see Section 3.0) and sub-functions (variable dependent on general wetland type) of each assessed wetland. Ratings are provided as "High," "Medium," or "Low" relative only to other wetlands of the same type. Each sub-function is evaluated using a unique set of field indicators presented as questions or metrics on a field assessment form. The assessor selects the appropriate answer(s), or descriptor(s), for each metric. The descriptors are converted by a computer program into a functional rating for each metric. Metric ratings are combined to generate sub-function ratings. Metric combinations are carried out using a weighting scheme that reflects the relative importance of the metric to wetland sub-functions to generate sub-function ratings. Likewise, sub-function ratings are combined to generate function ratings, and wetland function ratings are combined to yield an overall wetland functional rating.

Redoximorphic features – Features formed by the processes of reduction, translocation, or oxidation of iron and magnesium oxides. Formerly called mottles and low chroma colors (Field Indicators of Hydric Soils in the United States: Guide for Identifying and Delineating Hydric Soils, Version 6.0, 2006).



Reentrant – A reentrant appears on a topographic map as a U or V shape in the contour lines, pointing upward into a hillside rather than sticking out of the hill (as would a spur) (see illustration). A reentrant is a small valley, the center of which would collect water and funnel it downhill. This portion of a map includes several reentrants, three of which are circled. The west-most is a small, v-shaped reentrant, while the two eastern examples are broad and somewhat shallow. Also see "crenulation."

Regulatory agencies – For the purpose of NC WAM, this term refers to agencies involved with environmental permitting, whether a permit authorizer or a commenting agency.

Reference domain – The geographic area (such as an ecoregion or physiographic province) from which reference wetlands are selected. A reference domain may or may not include the entire geographic area in which a wetland type occurs (USACE 2006).

Reference (wetland/condition) – A reference wetland (or wetland in reference condition) is a discrete wetland identified and judged by an interdisciplinary team as being a typical, representative, or common example of that particular wetland type without or removed in time from substantial human disturbance. WFAT recognizes that the term "reference wetland" includes a range of biotic and abiotic characteristics within each recognized wetland type and considers "reference" to be synonymous to "relatively undisturbed." An appropriate reference wetland needs to be of a comparable type to the wetland being assessed, sometimes at a finer resolution than the general wetland type level of condition. For instance, Pocosins may occur on mineral soils or organic soils, and an appropriate reference wetland for a mineral soil Pocosin will be one found on mineral soils.

Riparian – Pertaining to the boundary between water and land. A riparian area or zone normally represents the streamside zone and the influence of the stream toward the upland (USACE 2006). Riparian areas or zones help protect the water by removing or buffering the effects of excessive nutrients, sediments, organic matter, pesticides, or pollutants (http://www.enr.state.nc.us/html/r_-_terms.html).

Riparian buffer – See "buffer."

Riparian wetlands – Riparian wetlands are wetlands adjacent to streams and rivers (NCDEM 1995).

Riverine wetlands – A term referring to wetland types typically found in one or more of the following landscape positions: within a geomorphic floodplain, associated with a natural linear conveyance, associated with a natural lake greater than or equal to 20 acres in size (which will be subject to seasonal fluctuations in water table), and subject to tidal flow regimes (see NC WAM wetland type key). Riverine wetlands include the following NC WAM general wetland types: Salt/Brackish Marsh, Tidal Freshwater Marsh, Non-Tidal Freshwater Marsh, Bottomland

Hardwood Forest, Riverine Swamp Forest, Mountain Bog, Floodplain Pool, and Headwater Wetland.

Saline waters – NC WAM considers brackish, estuarine, and salt water to be included in this category; any waters in which ocean-derived salts measure 0.5 parts per thousand or greater.

Salt water (marine system) – Water typically influenced by the ebb and flow of lunar tides in which salinities exceed 30 parts per thousand (Cowardin et al. 1979).

Sandhills – The Sandhills level IV ecoregion is a subset of the Southeastern Plains level III ecoregion. This area occurs in the southwestern portion of the Southeastern Plains and is characterized by unconsolidated, sandy soils deposited by erosional forces during the Pleistocene epoch.

Sandy soil – A soil material that contains 85 percent or more of sand (www.soils.org/sssagloss/search.html). This term refers to soils that have a USDA texture of loamy fine sand and coarser (USDA 2003).

Sapling – A woody plant with stems less than 5.0 inches diameter at breast height (DBH) and 20 feet or taller (Federal Manual for Identifying and Delineating Jurisdictional Wetlands, Part III, USACE et al. 1989).

Saturation/saturated soil condition – A condition in which all easily drained voids (pores) between soil particles in the root zone are temporarily or permanently filled with water to the soil surface at pressures greater than atmospheric (USACE 2006).

Seep – Seeps are areas semi-permanently to permanently saturated by ground water discharge and are underlain by mineral or organic soils (USACE 2006). For the purpose of NC WAM, these areas are typically found on sloping hillsides where impervious layers force ground water to the surface. Groundwater-fed areas in geomorphic floodplains or headwater wetlands are placed in other general wetland types.

Sedimentation/Deposition – This term refers to the deposition or accumulation of eroded soil material (sediment) that has been transported into a wetland or open water system by moving water.

Severely – A descriptive term used to emphasize the extent to which an event affects an object or the environment – in this case, having enough substance to make an extreme difference. When this term is used in NC WAM, it is typically followed with descriptive examples.

Sheltered areas (with reference to marshes adjacent to open water) – Shorelines anticipated to be regularly subject to waves of less than 1 foot in height are considered to be "sheltered." NC WAM considers an open water width of less than 2500 feet to provide too little fetch for regular development of waves meeting or exceeding this threshold. Also, shorelines adjacent to open water without regular boat traffic that generates high-energy wakes are considered to be "sheltered." "Exposed areas" are the opposite of "sheltered areas."

Short-duration inundation – This term refers to a situation in which the period of inundation for a single event ranges less than 7 days during the growing season.

Shrub – A woody plant 3 to 20 feet tall including multi-stemmed, bushy shrubs and small trees and saplings (Federal Manual for Identifying and Delineating Jurisdictional Wetlands, Part III, USACE et al. 1989).

Snag – A standing dead tree or part of a dead tree from which at least the leaves and smaller branches have fallen; often called stumps if less than 20 feet tall (www.enr.state.nc.us/html/s_-_terms.html).

Soil ribbon – Ability to form a soil ribbon eliminates sand and loamy sand as soil texture possibilities in a texture-by-feel analysis. To make a soil ribbon, place a ball of soil between thumb and forefinger, gently push the soil with the thumb, and squeeze it upward into a ribbon. The length of a soil ribbon is related to the amount of clay in the soil. Longer ribbons indicate a relatively higher clay content, while shorter ribbons indicate a relatively smaller clay content.

Soluble Change – A sub-function under the water quality function of wetlands. Soluble change refers to the ability of a wetland to remove and hold dissolved materials from the water column. An example of soluble pollutants is nutrients that are readily water soluble, such as nitrate nitrogen.

Southeastern Plains level III ecoregion – This ecoregion occurs in the western portion of the Coastal Plain physiographic province and includes the Sandhills level IV ecoregion (see Figure 1 and Appendix F for ecoregion maps. This ecoregion, with the exception of the Sandhills, is considered synonymous with the Inner Coastal Plain. The Southeastern Plains ecoregion consists of irregular plains with broad interstream areas. The Cretaceous- or Tertiary-age sands, silts, and clays of the region contrast geologically with the older metamorphic and igneous rocks of the Piedmont to the west. Elevations and relief are greater than in the Middle Atlantic Coastal Plain to the east. Streams in this area are relatively low gradient and sandy bottomed (Griffith et al. 2002).

Strahler stream order – A simple method of classifying stream segments based on the number of tributaries upstream. A stream with no tributaries (headwater stream) is considered a first-order stream. A segment downstream of the confluence of two first-order streams is a second-order stream. Thus, a $n^{th}$-order stream is always located downstream of the confluence of two $(n-1)^{th}$-order streams (Strahler 1952). See Appendix C for a schematic diagram of stream order. The assessor should consider both intermittent and perennial streams when making a stream order determination (ephemeral channels are not included in the determination).

Stream – This term is generally applied to the water flowing in a natural channel as distinct from a man-made canal or ditch (http://ga.water.usgs.gov/edu/dictionary.html).

Stream order (see also Strahler stream order) – Stream order is generally determined by consulting blue lines on the USGS 7.5-minute quadrangle and calculating the order number using the Strahler method. See Appendix C for a schematic diagram of stream order. The assessor should consider both intermittent and perennial streams when making a stream order determination (ephemeral channels are not included in the determination). The assessor may defer to field observations over USGS topographic maps. For the purposes of NC WAM, a zero-order stream is a stream not shown on the most recent version of the 1:24,000 USGS

topographic map. Also for the purposes of NC WAM, an assessor should not necessarily count blue-line ditches in the Middle Atlantic Coastal Plain ecoregion as first-order streams. Best professional judgment will be needed to estimate stream order in this landscape.

Stressor – A typically anthropogenic activity which affects one or more wetland functions by altering the wetland from reference condition. The response of a wetland to a stressor depends on wetland type, size, and severity of the stressor. Examples of stressors may include nutrient enrichment/eutrophication, organic loading and reduced dissolved oxygen, contaminant toxicity, acidification, salinization, sedimentation/burial, turbidity/shade, vegetation removal, thermal alteration, dehydration, inundation, fragmentation of habitat (Adamus and Brandt 1990), and soil disturbance. Stressors are anticipated to always degrade the condition of a wetland; but, to some extent, stressors may benefit the opportunity of some water quality functions.

Sub-function – This term refers to the supporting but distinct components of each of the three designated wetland functions as determined by WFAT. Hydrology sub-functions include 1) surface storage and retention and 2) sub-surface storage and retention; Water Quality sub-functions include 1) particulate change, 2) soluble change, 3) pathogen change, 4) physical change, and 5) pollution change; and Habitat sub-functions include 1) habitat physical structure, 2) vegetation composition, 3) landscape patch structure, and 6) uniqueness.

Substantially – This is a descriptive term used to emphasize the extent to which an event affects an object or the environment – in this case, having at least enough substance to make a difference. When this term is used in NC WAM, it is typically followed with descriptive examples.

Surface Water Classifications – Designations applied to surface waterbodies, such as streams, rivers, and lakes, defining the best uses to be protected within the waters (exp. swimming, fishing, drinking water supply) (http://www.enr.state.nc.us/html/s_-_terms.html).

Tidal – This term typically refers to a situation in which the water level periodically fluctuates due to the action of lunar and solar forces upon the rotating earth (Environmental Laboratory 1987). "Wind tides" refer to water table fluctuations due to the action of wind on the water surface. For the purpose of NC WAM, lakes or waterbodies greater in size than 20 acres may be considered to be subject to wind tides.

Treatment capacity (of a wetland) – This term refers to a wetland's ability to treat pollutants, entering the wetland through either surface or sub-surface discharges. For the purposes of NC WAM, the level of capacity is not as important as evidence of a discharge and evidence that the wetland's treatment capacity is being exceeded by the discharge.

Tree – A woody plant greater than or equal to 5 inches in diameter at breast height (DBH) and 20 feet or taller (Federal Manual for Identifying and Delineating Jurisdictional Wetlands, Part III, USACE et al. 1989).

Trout waters (Tr) – NCDWQ supplemental classification intended to protect freshwaters for natural trout propagation and the survival of stocked trout. To receive a Tr classification, the proposed water body must have conditions which will sustain and allow for trout propagation and survival of stocked trout on a year-round basis (15A NCAC 2B .0200).

Underground Storage Tank (UST) - A tank located all or partially underground that is designed to hold chemical solutions, gasoline, or other petroleum products (www.enr.state.nc.us/html/u_-_terms.html).

Unique Wetland – "Unique Wetland" (UWL) is a N.C. Environmental Management Commission (EMC) regulatory designation (15 NCAC 02H .0506). To be so designated, a wetland must meet uniqueness criteria and be formally classified. Assessors will need to reference mapping and descriptions generated by the EMC for this determination.

Value – Value refers to the benefits, goods, and services that result from wetland functions. For example, one function of many wetlands is the storage of surface water; the value of that function is to reduce flood damage. Value may be increased by the location of a wetland within a watershed whereby the wetland has an increased opportunity to provide a particular function.

Variable(s) (wetland) – Within NC WAM, a variable is a visual indicator in the field which evidences that functional benefits are being provided by a wetland. For instance, a recognized sub-function of the Hydrology function is surface storage and retention. One benefit of surface storage and retention is energy dissipation, and a field variable providing evidence of the benefit of energy dissipation may be wrack lines against vegetation adjacent to a stream bank.

Very long duration (flooding) - A duration class in which the length of a single inundation event is greater than 1 month during the growing season (Environmental Laboratory 1987).

Well connected (wetland) –This term generally refers to a wetland surrounded by or adjoining a natural habitat patch along a substantial part of its boundary on at least one side.

Water quality – Descriptive or quantitative conditions of water, usually in reference to physical, chemical, and biological properties, and usually from the perspective of society's use.

Watershed – The NCDWQ (and NC WAM) considers the watershed to be the entire land area contributing surface drainage to a specific point (15A NCAC 02B .0200). The USACE uses the term "catchment" to refer to this same concept.

Water table – Water table is the surface of the saturated zone below which all interconnected voids are filled with water and at which the pressure is atmospheric (15A NCAC 02L .0102(27).

Wetland(s) – "Wetlands" are areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas (33 CFR 328.3(b)).

Wetland assessment area – See Assessment area

Wetland assessment form –This form is used by NC WAM to document conditions within an assessment area during a rapid field assessment. Information recorded on this form is used to generate a functional rating of an assessed wetland.

Wetland complex – An association of two or more wetland types that are contiguous and hydrologically connected to each other.

Wetland delineation/determination – The U.S. Army Corps of Engineers defines wetland determination as "the process or procedure by which an area is adjudged a wetland or nonwetland" (Environmental Laboratory 1987). For the purpose of NC WAM, both wetland delineation and wetland determination are terms that indicate that a wetland/upland boundary has been identified properly according to guidance provided in the Corps of Engineers Wetland Delineation Manual (Environmental Laboratory 1987).

Wetland Functional Assessment Team (WFAT) – An interagency (federal and state) team sponsored by NCDENR, NCDOT, and USACE and tasked with developing a rapid wetland functional assessment methodology for the state of North Carolina. WFAT was formed in 2003 and released the NC WAM product in mid-2007.

Wetland functional rating – See "rating."

Wetland type – This term refers a continuous wetland area comprised of one of the 16 general wetland types defined for use by NC WAM. The boundary of a wetland type may consist of a wetland/upland boundary or another wetland type. A wetland type determination may be made based on general wetland type descriptions provided in the User Manual, with the use of the NC WAM Dichotomous Key to General NC Wetland Types, or following guidelines provided for the identification of unique or problematic wetland types.

Zero-order stream – This term refers to a stream that exists on the ground but is not shown on a USGS 7.5-minute topographic quadrangle.